Special Supplement
SMITHSONIAN ASTROPHYSICAL OBSERVATORY
BULLETIN NO. 6
FOR VISUAL OBSERVERS OF SATELLITES

# Sky and TELESCOPE

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**An Astronomer Looks at Space Travel**

**An IGY Program of Meteor Observing for Amateurs**

**Observing at Junipero Serra Peak**

**Some Recent Work on the Orion Nebula**

**Visual Aurora Observing During the IGY**

**Northern and Southern Star Charts**


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**Vol. XVI, No. 7**

**MAY, 1957**

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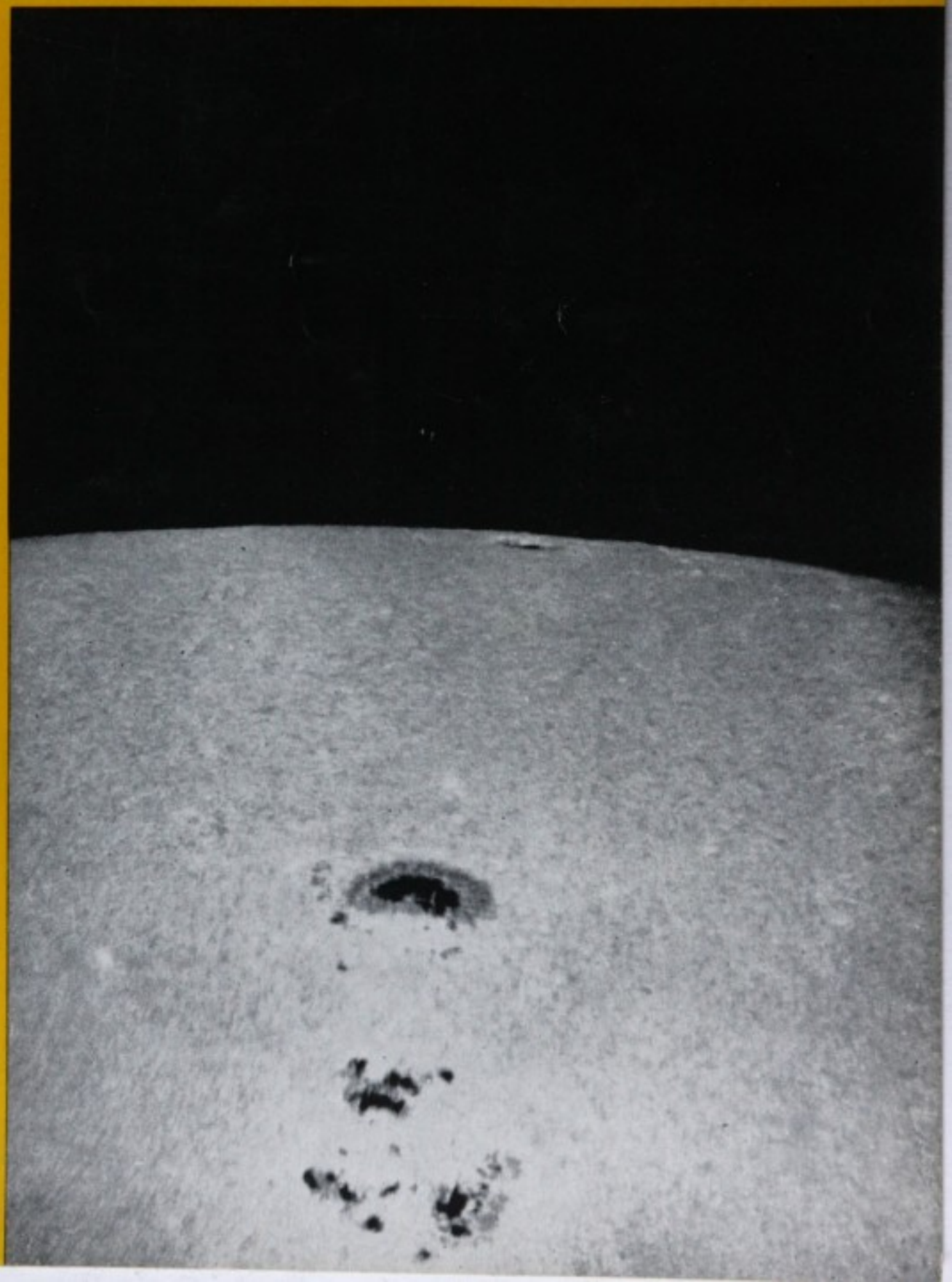
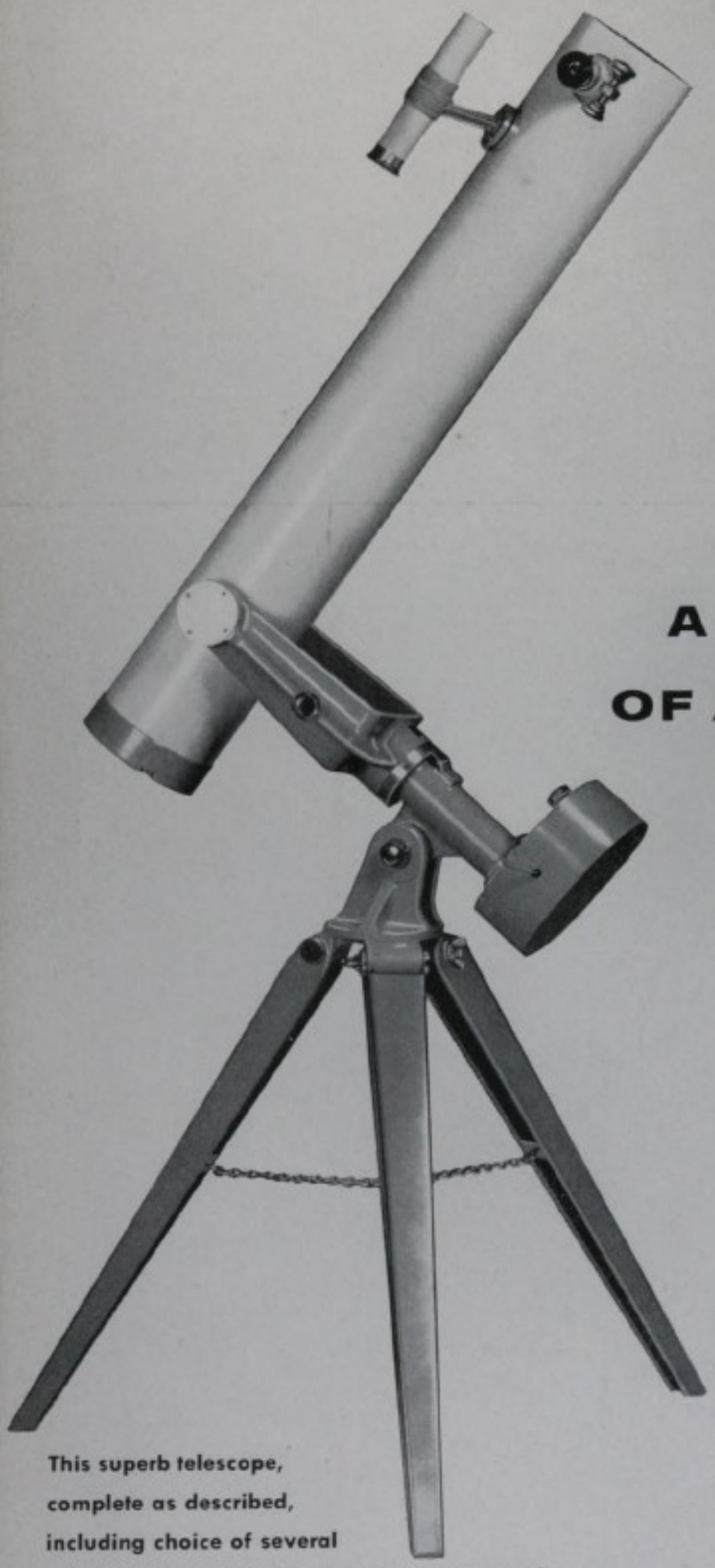


The sun's surface



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**COVER:** This picture of the sun's surface and limb was taken by Leon G. Salanave from Junipero Serra Peak in California, 5,862 feet above sea level. It was made at 7:05 a.m. PST on September 4, 1956, when seeing conditions were excellent, as is indicated by the extreme sharpness of the sun's edge. Very close to the limb, a greatly foreshortened spot gives the appearance of a depression in the solar photosphere. In the lower part of the field a large sunspot group has bright plages associated with it. The scale of the reproduction is about one millimeter to two seconds of arc; the exposure was 1/250 second with a 6½-inch refractor, Herschel wedge, and enlarging camera. California Academy of Sciences photograph. (See page 320.)

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# A Radio Observatory in the Owens Valley

THE largest radio telescopes of their type in this country, twin paraboloids each 90 feet in diameter, are being constructed by the California Institute of Technology at its new radio observatory near Big Pine, California. The early work on this installation is described by John G. Bolton in the February issue of the *Griffith Observer*. The project is being financed by the Office of Naval Research.

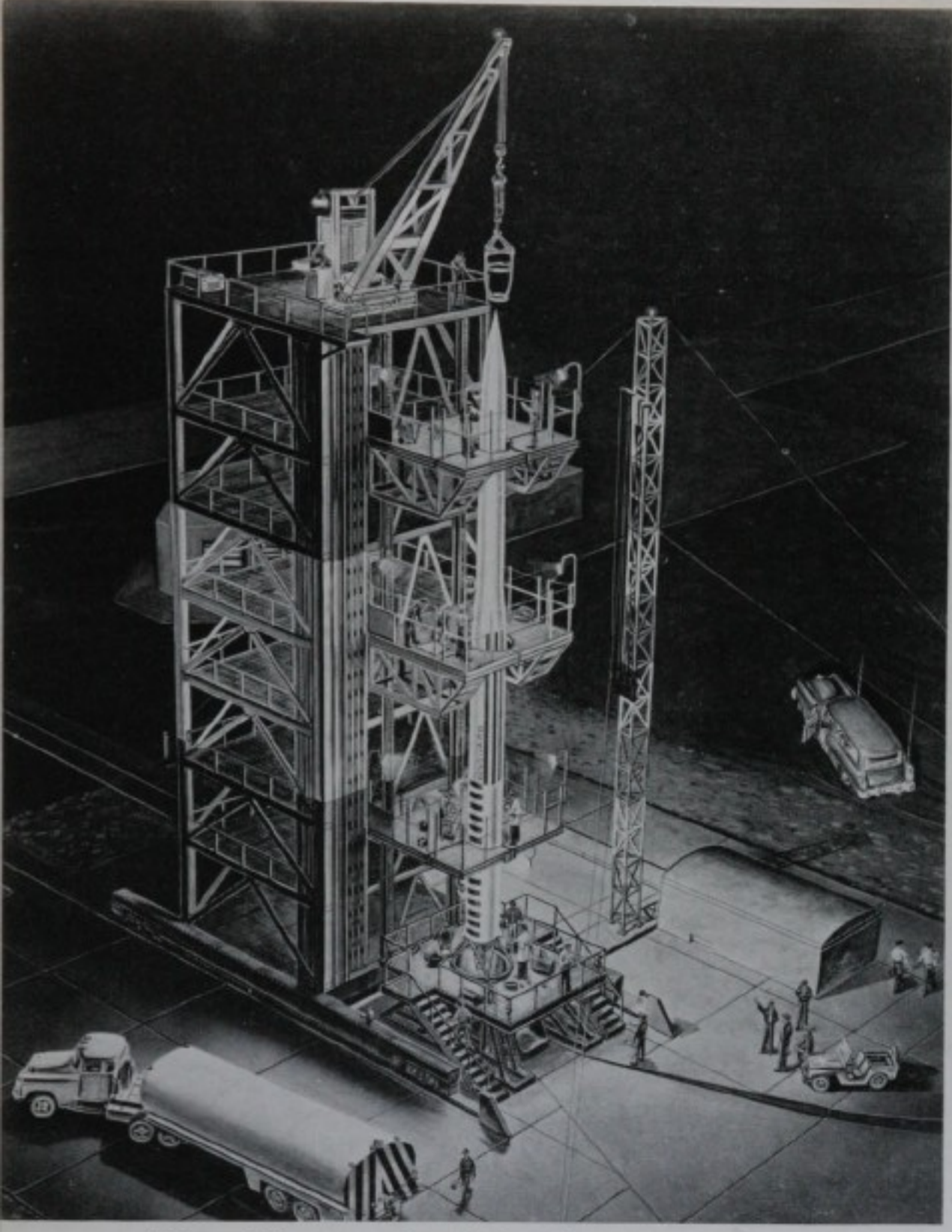
Each reflector antenna will weigh some 40 tons, and its mounting twice this much. They will be placed on railroad flatcars which will run on rails 1,600 feet long. The two antennas can thus be widely separated to form the components of an interferometer. Individually, at a wave length of 40 centimeters, the antennas will have a positional accuracy of five minutes of arc and a field of view of about one square degree, but in interferometer form they together should determine positions of radio sources to 0.1 or 0.2 minute of arc.

Buried in the ground along the 1,600-foot track will be a copper wave guide 6 by 12 inches in cross section; this will provide the main radio-frequency interconnection between the antennas. The complete installation will require nearly 80 miles of electrical cable.

Each antenna will be restricted in hour angle to four hours on each side of the meridian, thereby reducing construction costs considerably and eliminating cantilevering of the axes. In declination, the antennas will have full coverage. The practicability of this mounting design has been determined by a 32-foot reflector at Palomar Observatory.

This test instrument has been used advantageously for observations of the 21-cm. hydrogen line. Dutch astronomers have been leaders in radio research on the structure of the galaxy, but their telescopes have been unable to observe that part of the southern Milky Way between galactic longitudes 200° and 330°. Because Palomar Mountain is roughly 20 degrees nearer the equator than is the Netherlands, Mr. Bolton points out, this unobserved section can be cut down to a span of only 50 degrees, from 245° to 295°.

Nearly six months were spent in the site search for this radio observatory. Several desert locations were found to be free of man-made radio interference, but the Owens Valley offered water and power supplies and a good access road as well. Three hundred acres were leased through the Los Angeles Water and Power Board on land about four miles north of Big Pine, to the east of the towering peaks of the Sierra Nevada mountain range. Site assembly of the antennas is now under way.



A Vanguard three-stage rocket on its launching table at Cape Canaveral, Florida, as conceived by Nick Stanilla, staff artist of the Glenn L. Martin Co., primary contractor for the satellite vehicle. The rocket, 72 feet long and weighing 11 tons, is upright in the gantry structure. Engineers on the platforms check the instruments and controls, while a fuel truck brings up the liquid propellants for the first two stages. When the rocket is ready for fueling, the hinged gantry platforms are swung clear, and the eight-story crane rolls back along its tracks. This and four other paintings of the Stanilla series are courtesy the Martin Company.

# An Astronomer Looks at Space Travel

VICTOR M. BLANCO

*Warner and Swasey Observatory*
*Case Institute of Technology*

MAN has always dreamed of traveling away from the earth to visit the moon, the other planets, and the stars. The fulfillment of this dream, which may be traced back to the most ancient myths, will be mankind's greatest adventure.

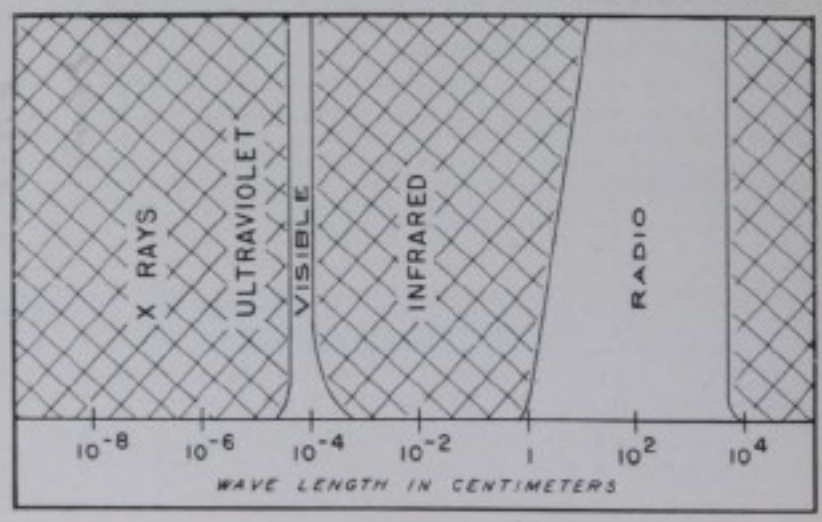
Why should we wish to venture away from the safety of mother earth out into the vastness of space? Great undertakings are sometimes hard to justify in terms of dollars and cents even though they can be richly rewarding in less tangible ways. Few can read about the achievements of the great explorers of the past without feeling pride that a fellow man has attained such difficult goals. However, space travel will be an undertaking of the utmost importance, as well as an accomplishment deserving of our collective pride.

Apart from the possible military uses of space travel, we will gain valuable new knowledge in many fields of science. Curiously enough, space travel will help geophysicists to learn more about the interior of the earth. The accelerations experienced by space craft in the vicinity of the earth will yield new information about the internal structure of our planet.

Meteorology will also benefit by observation from outer space. In spite of our complex global network of weather stations, at present there are huge ocean areas where a hurricane or typhoon may lurk unobserved, only to appear unexpectedly over some densely populated region. A watch post far out in space would help us to track the course of major storms with accuracy.

The nature and direction of travel of cosmic rays may be studied in space without the marked changes caused by the earth's atmosphere and magnetic field. Such observations could well make the analysis of cosmic rays a common part of astronomical research, adding the Geiger-counter telescope to optical and radio telescopes as major tools of the astronomer of the future.

For astronomers, the ability to observe the heavenly bodies from outside of the




Optical and radio telescopes can study astronomical bodies only through two restricted atmospheric windows. Some other regions of the spectrum are partially transparent, as in the infrared. A space station would permit observation of the blacked-out regions as well.

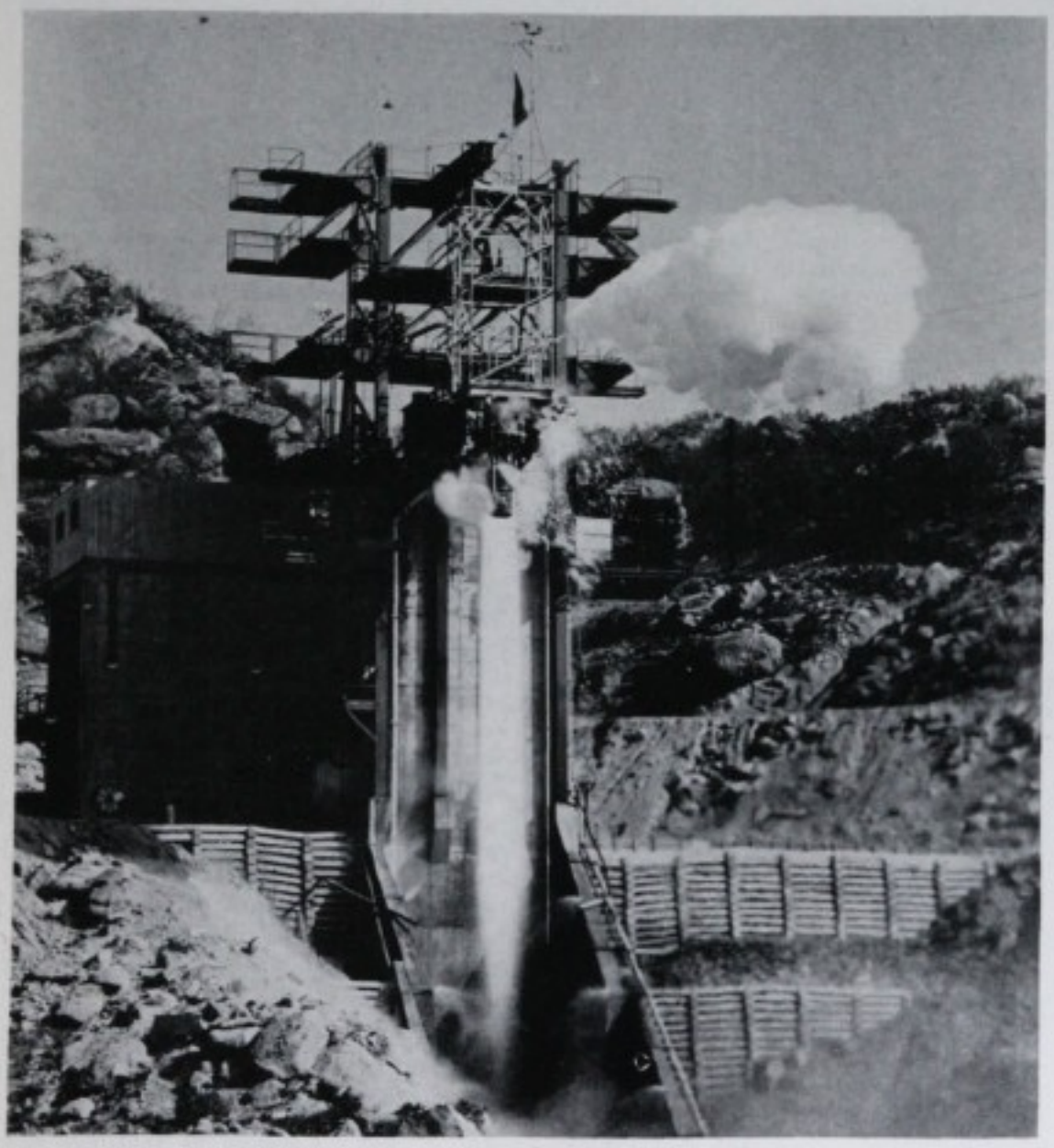
atmosphere will mean a revolutionary improvement in the accuracy of their observations, as well as the means to tackle problems that at present cannot be solved. For example, if an observatory can be placed on the moon or on an artificial satellite, telescopes will be able to penetrate much deeper into space, unhampered by the atmospheric effects that now plague us. The variations in telescopic image quality collectively known as "seeing," which are caused by the refraction and diffraction of light rays as they pass through the earth's atmosphere, will be eliminated entirely.

Photographic plates will not be fogged as badly in long exposures by the over-all sky brightness, which is due partly to the glowing air in the ionospheric regions, and partly to the random scattering of light rays in the atmosphere. Not all the sky brightness will be eliminated in observations made outside of the atmosphere, however, for the dust found between the planets also scatters light, and the background of the heavens will always be illuminated by the total aggregate of distant stars and galaxies. Indeed, the study of this residual illumination will help in determining how both the interplanetary dust and the distant galaxies are distributed in space.

The ultraviolet and infrared regions of the spectrum will no longer be blocked out by the atmosphere. This blocking is serious, for stars as blue or bluer than Vega have their maximum intensity of radiation in parts of the spectrum too far in the violet to shine through our atmosphere, while the reddest stars known radiate chiefly in infrared colors that are at least partly absorbed by the atmosphere.

Atmospheric extinction, or the amount by which the intensity of light rays is cut down by our atmosphere, would be eliminated in an outer-space observing station. At present, this factor must be evaluated as exactly as possible, if we want to determine the brightness of stars with the precision inherent in electronic photometry. The elimination of the atmospheric absorptions would also be beneficial in radio astronomy. Very short radio waves are affected by water vapor, while waves longer than 30 meters are not passed by the ionosphere. Observations at a lunar observatory could thus be made to cover the entire electromagnetic spectrum.

**This first test firing in the satellite vehicle program was made at 1 a.m. on December 8, 1956. Shown here seconds after its launching by Naval Research Laboratory scientists at Patrick Air Force Base, the Viking rocket soared to an altitude of 125 miles. The first stage of the satellite vehicle is to be a modified Viking. Official U. S. Navy photograph.**

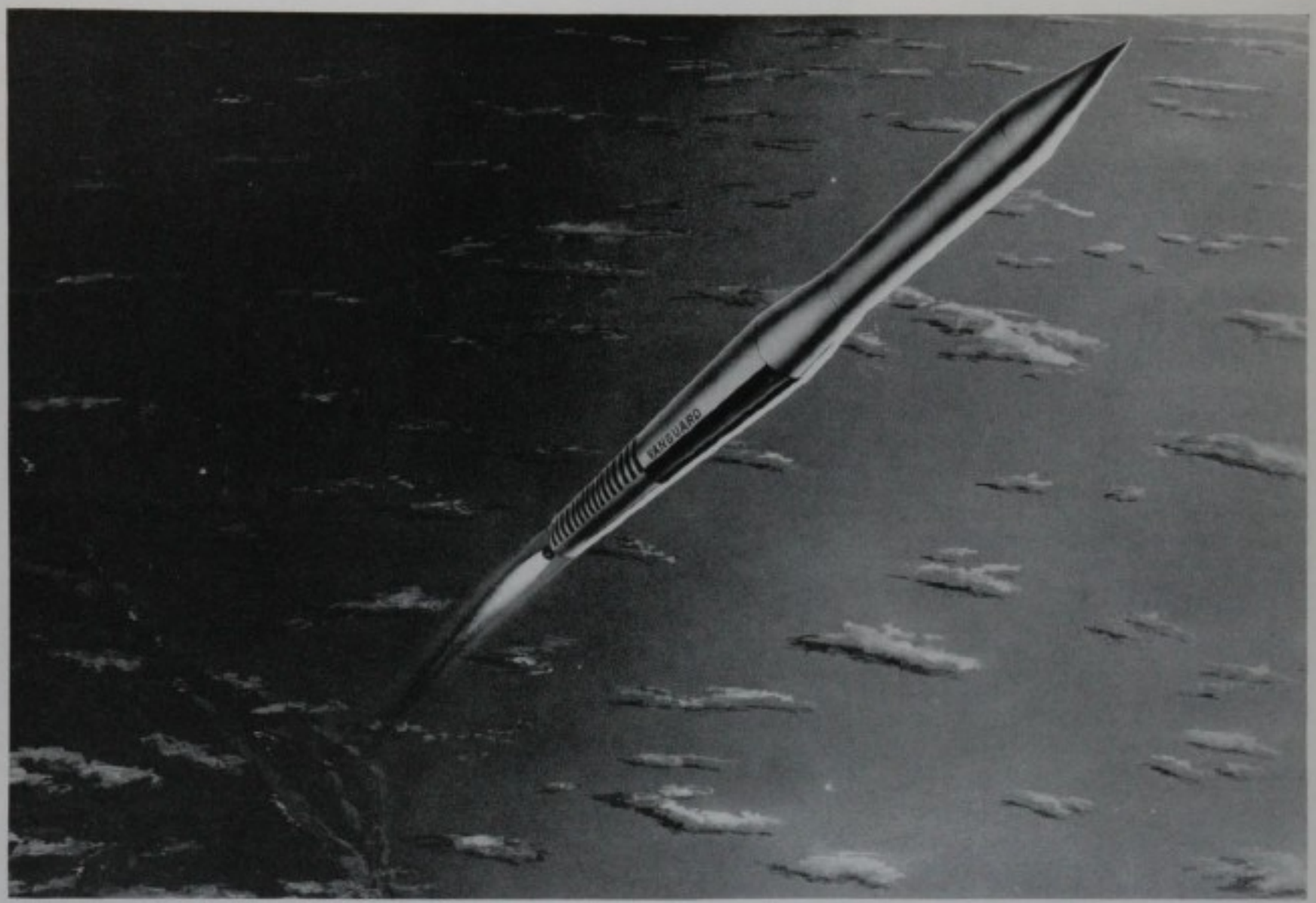


**A critical phase in the development of a new rocket motor: its static firing test to measure thrust and to determine other performance characteristics. The intense downward blast of the rocket is turned aside by a concrete exhaust deflector. Streams of cooling water play on the deflector to protect it. Note how blurred the layered retaining wall appears at the lower right, seen through the turbulent rush of hot exhaust gases. Courtesy General Astronautics Corp.**

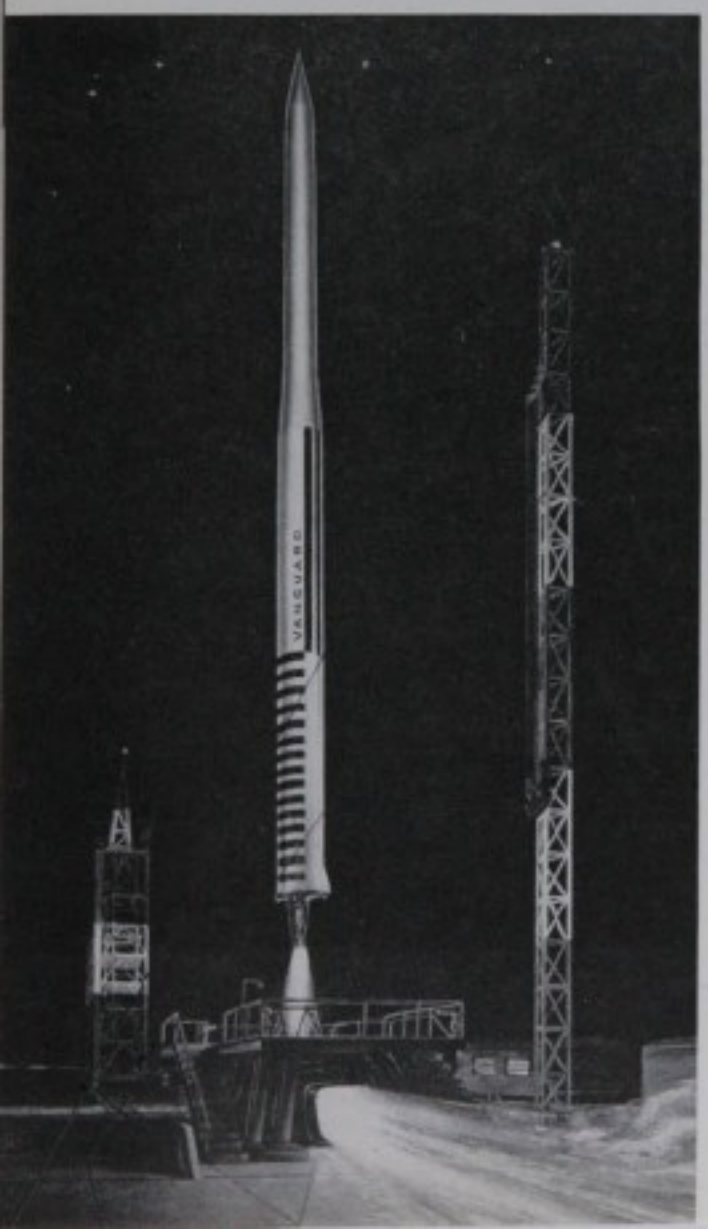
The bolometric magnitude of a star is a measure of the total rate of radiant energy output at all wave lengths. A knowledge of accurate bolometric magnitudes is fundamental in understanding the details of energy production, internal structure, and aging effects of the stars. Our present information on bolometric magnitudes is based upon the crude measurements that we can make through the atmosphere.

Most of the spectroscopic features originating from atoms and molecules in their lowest energy states, such as are likely to exist in interstellar space, are located in regions of the ultraviolet spectrum that are not observable at present. The observation of these features will permit a vastly more thorough analysis of the gases present in the space between the stars.

The telescope mountings in an observatory on the moon would be appreciably less massive than those on the earth, because of the smaller pull of lunar gravity. However, in order to take advantage of the sharper telescopic definition at the lunar observing post, we would have to keep the amount of flexure



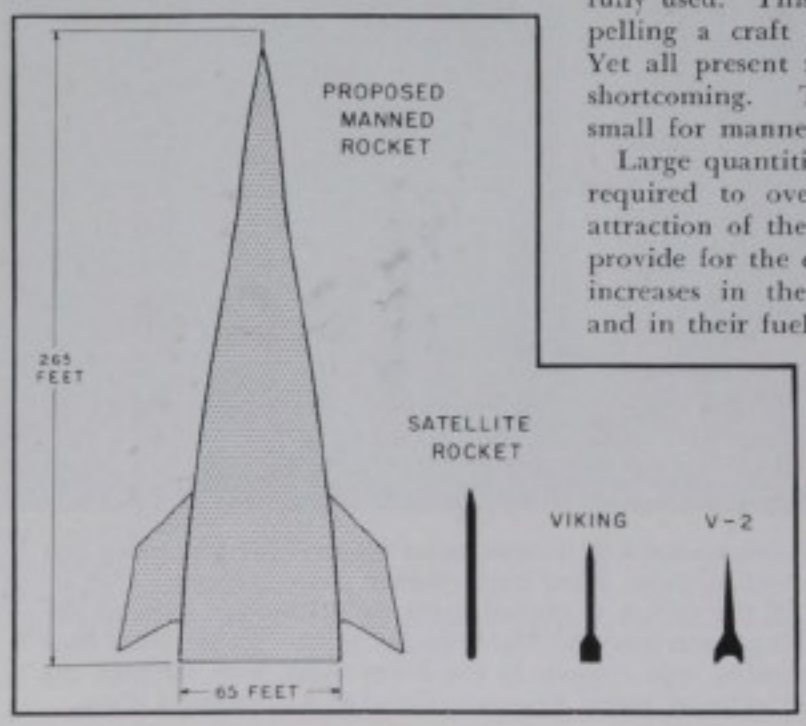

**The great launching vehicle, seen rising from the firing stand in the picture at the lower left, is shown above as it soars into our stratosphere. A part of the Florida coastline shrinks in the distance. At the moment of burnout of this first stage, the rocket will be some 35 miles high, traveling at an angle of roughly 45 degrees to the vertical. These are the second and third of the paintings by Nick Stanilla.**



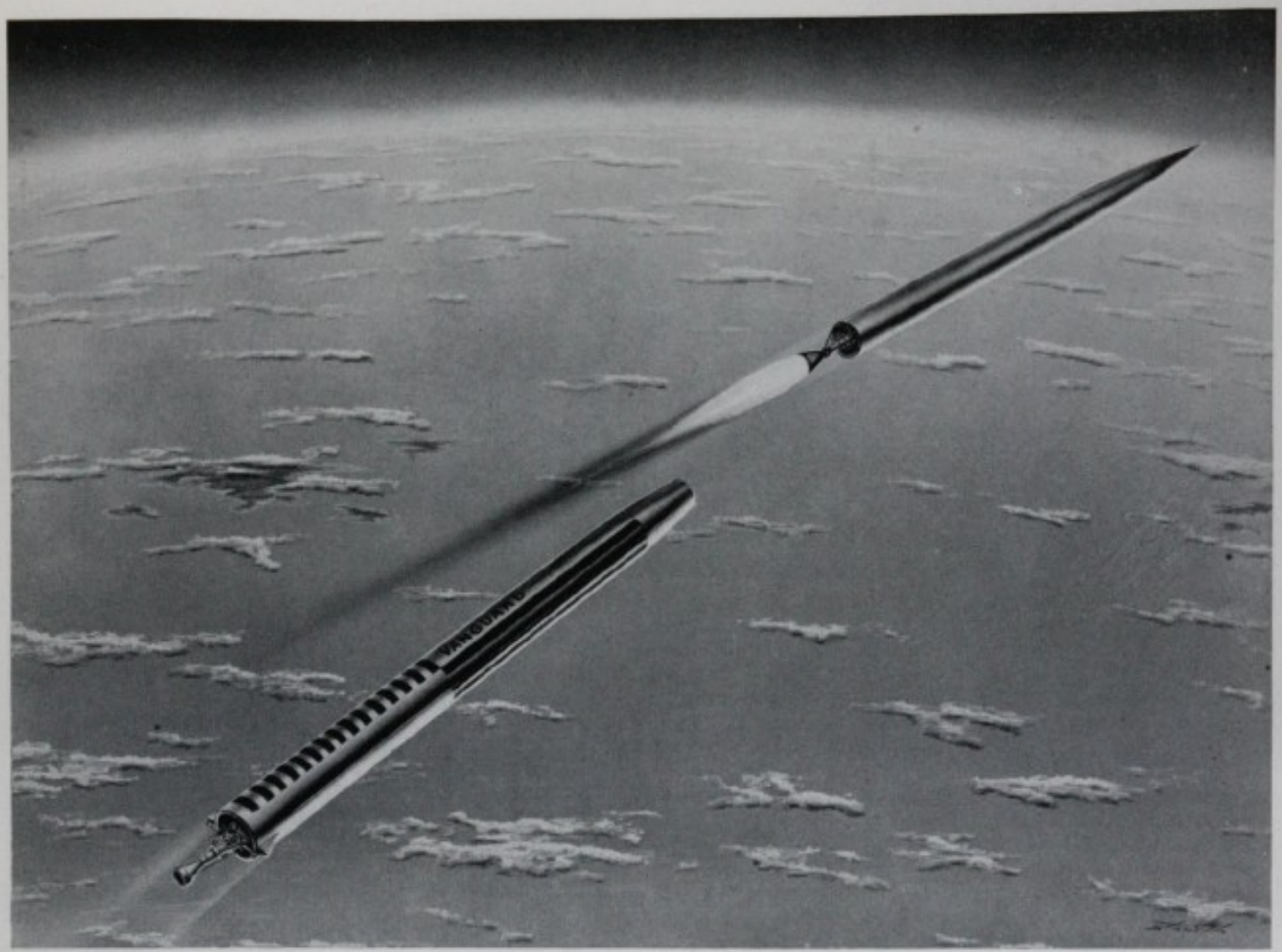

in the mounting very small. We could not simply scale down the rigidity of present-day telescopes in proportion to the decrease in gravitational attraction.

In view of the rapid engineering development of large rockets in the last few years, it appears that the age of space flight is not too distant in the future. However, the current flood of space-travel talk, some of it based on facts, some on pure fiction, is causing many of us to overlook the serious problems that must be solved before men travel away from the earth. Great advances in rocket design have been achieved since the first V-2 rockets were devised by the Germans. Current secret work on guided missiles is no doubt advancing the day of space flight. Airplanes that fly on the rocket-propulsion principle have been successfully used. This is the only way of propelling a craft in interplanetary space. Yet all present rockets have one serious shortcoming. They are entirely too small for manned space flights.

Large quantities of rocket fuel will be required to overcome the gravitational attraction of the earth. Furthermore, to provide for the comfort of the crew, vast increases in the size of rocket vehicles and in their fuel capacities will be neces-




**The relative sizes of present-day rockets and of a manned rocket proposed by Wernher von Braun to carry a payload of 36 tons from the earth to an altitude of 1,000 miles.**



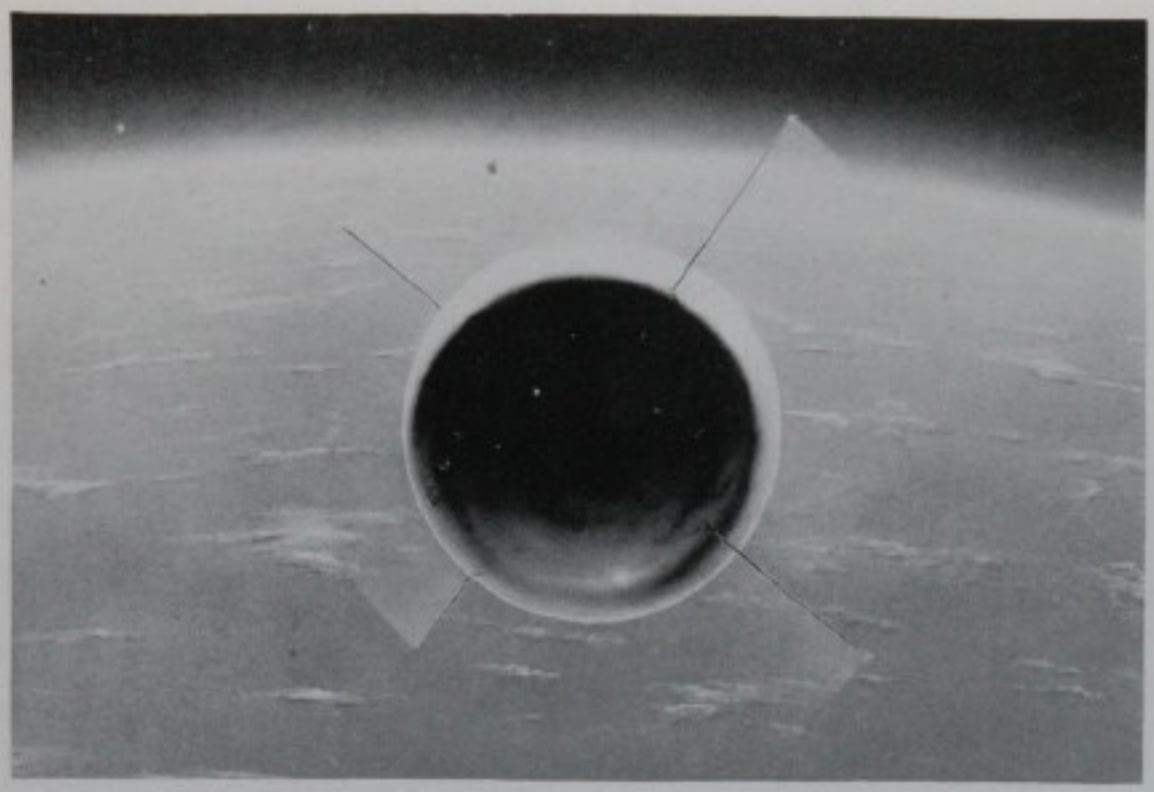

**As soon as the first stage burns out, it is jettisoned into the sea, and the second stage fires until an altitude of about 140 miles is reached. Each rocket motor is mounted on gimbals, so its impulse can be controlled to direct the Vanguard vehicle into the proper orbit. Inside the nose cone of the second stage is the third stage, with the 22-pound satellite.**

sary. We must find economical ways of building very large spaceships, and, if possible, devise more efficient fuels to propel these ships. The acceleration of the rocket depends not only on the speed with which burned fuel is ejected, but also on its quantity. During take-off, the more rapidly the rocket is accelerated, the more efficient it will be, and the less fuel will be needed to overcome the earth's attraction.

But the presence of a human crew will limit the acceleration to the level of human endurance. This means a compromise will have to be made in the efficiency of the rocket, and fuel requirements must be increased correspondingly. With sufficient fuel at hand, it will not be necessary to subject the passengers to the nearly lethal accelerations that are sometimes portrayed in space-travel motion pictures. Employment of nuclear energy to propel rockets will not necessarily lighten the fuel load, for matter of some kind must always be ejected; the nuclear energy will have to be converted to energy of motion of the ejected material. At present, we can only do this rather inefficiently.

So far we have no answer to the question, "How fast can a person be accelerated and stay not only alive but in good health?" To solve this and other related problems, scientists of the U. S. Air Force established a space-medicine department, where experimenters are obtaining some of the desired answers. Acceleration is measured in *g* units, where one *g* is the amount of acceleration of a freely falling body near the earth's surface. Human beings can stand up to about five *g*'s for limited periods. As yet,

**Living conditions during flight in outer space are simulated in this test chamber, designed by Hubertus Strughold, at Randolph Air Force Base. Elaborate instruments record the reactions of a test subject to the extremes of the artificial environment. James G. Guame, here seen inside the chamber, has spent as long as 24 hours without interruption sealed within it. Photograph courtesy North American Aviation, Inc.**



**In the last of the Martin Company drawings, the satellite is moving free in its 1½-hour orbit around the earth. The sun illuminates half of the 20-inch magnesium sphere, while stars are reflected from its dark side.**

however, we do not know what accelerations can be tolerated for longer intervals than a few seconds.

The effect of weightlessness on a space traveler is another medical problem of great interest. Experimental information about the effects of weightlessness is extremely difficult to obtain, for we have not contrived a method for exposing subjects to this condition for prolonged time intervals. In high-altitude rockets, experiments of this type can be made with animals. There are reasons for believing that serious physiological and psychological maladjustments could result from long weightlessness, because such a condition would render ineffectual the balance and orientation mechanisms of the human body as well as its gravity-dependent muscular responses. It is thus commonly accepted that for prolonged stays in outer space a substitute for gravity will have to be generated by centrifugal acceleration or other means. The wide interest that the problems of space medicine have awakened has already led to many publications on this subject. The reader interested in these matters can consult *Physics and Medicine of the Upper Atmosphere*, edited by C. S. White and O. B. Benson, University of New Mexico Press, 1952; and *Space Medicine*, edited by J. P. Marbarger, University of Illinois Press, 1951.

Collisions with meteorites will be a hazard to space flight. The most frequent collisions will be with relatively small dust-grain-sized meteoroids. According to Harvard astronomer Fred L. Whipple, a meteor bumper consisting of a thin outer skin surrounding the space craft will offer sufficient protection. The effectiveness of such a bumper will depend on how often meteoritic particles of various sizes will be encountered.

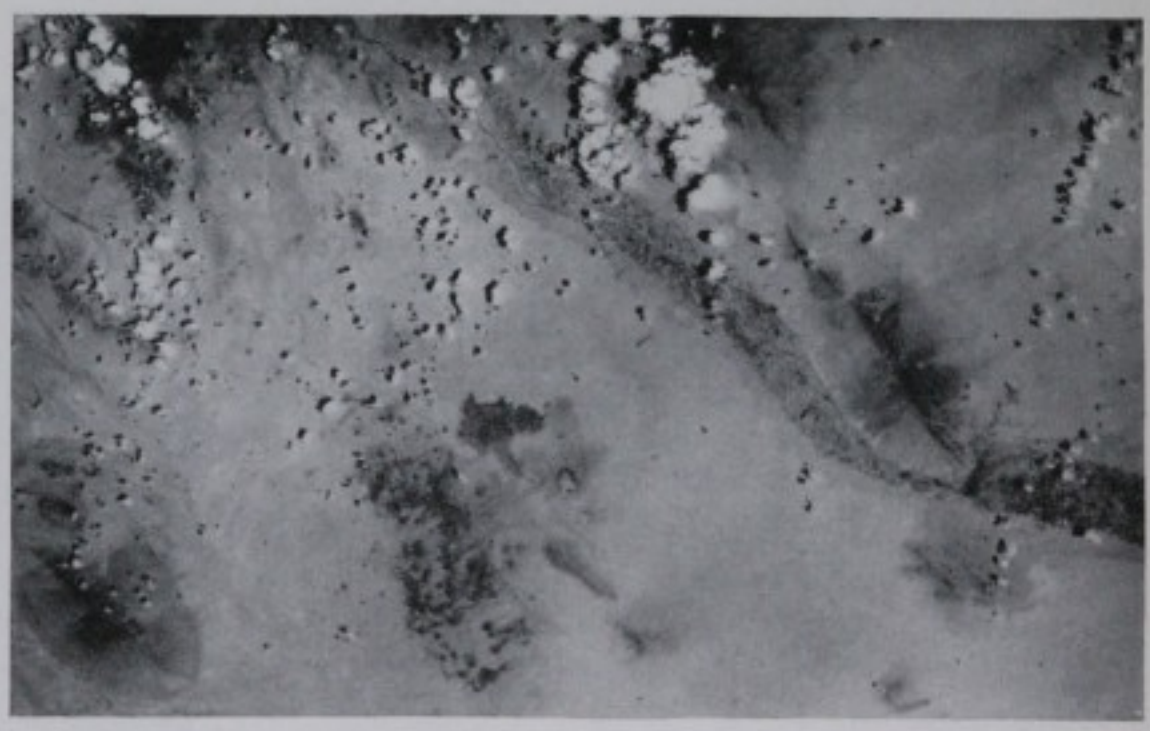
This information could be gathered in advance by means of artificial satellites. If space travelers stay away from regions of high particle concentration, such as exist in the orbits of the meteor swarms, the chances will be small of collisions with meteorites large enough to penetrate the walls of the vehicle. Of course, it should be possible to avoid collisions with meteorites sufficiently large for early radar detection, as well as to repair minor collision damage while in flight.

Considering the problems that must be solved before space travel becomes a reality, one may hazard a guess as to the sequence of developments in the near future. After the successful completion of present artificial satellite experiments, we will probably increase the instrument-carrying capacity of the satellites. The next step will be to send relatively small unmanned rockets to the moon, possibly on round-trip journeys.

By means of automatic observing and recording instruments, we will study the earth from a distance, measure the magnetic field of the moon, and record the lunar surface in detail, including the never-seen far side. These experiments appear so near at hand that one may venture to say that in the next decade or so we will be living through the excitement of such explorations. Similar studies of some of the other planets and of the space near the sun will follow. The scientific rewards and the desire for international prestige should stimulate continuous government-supported efforts along these lines.

Manned space travel, however, with the problems brought about by vast increases in weight, limited take-off acceleration and comfort of the crew, does not seem likely in the near future. As a stimulus for the solution of these problems, we must not overlook the fact that the future of commercial aviation will call for the development of aircraft that will have more and more of the requirements of manned spaceships.

Our present generation probably must be content with such information as may be gained from automatic instruments projected into outer space. Perhaps the lunar observatory will be a project to be considered by the coming generation. Astronomers of the future will look back on our achievements possibly with a feeling akin to that of Admiral Byrd on flying over the North Pole and thinking how Peary and his men trudged their way to the same goal across the seemingly endless sea of ice below.



**A satellite's view of the earth, taken from the record height of 158 miles reached by Viking rocket No. 11 in May, 1954. The Rio Grande river runs diagonally across the picture, with north at the top. The white puffs are cumulus clouds; note their shadows. Official U. S. Navy photograph.**

# An IGY Program of Meteor Observing for Amateurs

PETER M. MILLMAN, *National Research Council of Canada*

TWO special meteor programs are being organized in Canada for the 20 observing months of the International Geophysical Year, which will extend from June 1, 1957, to January 31, 1959. These programs are designed to obtain improved statistical information relating to the numbers of meteors encountered by the earth and to the distribution of the sizes of these objects.

For the first program, radar equipment at Ottawa will operate continuously at a wave length near nine meters, to record radar echoes of meteors for 24 hours a day throughout the IGY. This equipment is being designed and built by the National Research Council of Canada, particular attention being given to insuring uniform performance over extended periods. Four other radar installations, set up primarily for auroral observations at Ottawa, Saskatoon, Baker Lake, and Resolute Bay, will provide auxiliary information on meteor-echo rates on a wave length of six meters.

The second program, designed to supplement the first, is being organized jointly by the Dominion Observatory and the National Research Council. It will provide visual meteor rates and magnitude distributions for correlation with the radar observations. In this way it is hoped to calibrate the radio records and tie them in to the great mass of visual meteor data that now exist in the literature.

To carry out this second program and achieve the combined goal, a large number of volunteer visual meteor observers is required. This is an excellent opportunity for amateurs throughout the world, regardless of their observing experience, to participate in the world-wide activities of the IGY. As the instructions included in this article indicate, the observing procedures are simple and require no instruments or special equipment of any kind. Generally speaking, only the following observations will be required:

1. Counts of all meteors seen during successive 10-minute intervals.

2. An estimate of the brightness of each meteor to the nearest half magnitude.

3. A report of weather and sky conditions, and changes in these during observing periods.

Except for very bright meteors and fireballs, *it will not be necessary* to time accurately the appearance of individual meteors, nor to plot their paths on star maps.

Since the sky visible from one location can be covered more completely by a group of observers than by a single individual, participants in this program are encouraged to work in teams whenever possible. This should not, however, discourage the observer who must work alone, for there is a standard relation between the total of meteors recorded in a given period at one location and the size of the observing group. Hence, all observed meteor rates can be reduced to a common denominator, regardless of the number of observers.

**When To Observe.** Like all visual meteor work, the IGY meteor program calls for long and patient watching. The value of the record is not gauged by the total number of meteors counted, but by the care with which the instructions are followed and the skill acquired in the accurate reporting of what does occur. In this type of program negative results are just as important as positive results.

Therefore, observations made on any night, during evening or morning hours, will be of value. Much of the time no special meteor shower is active, and no unusual number of meteors will be seen. On the average, though, meteor rates are higher during the second half of the night.

Observers may therefore choose dates and times that fit in with other activities. It is true, however, that on certain *world days* (page 319) it is desired to have the night's coverage as complete as possible. Also, organizers of group observing can stimulate interest by scheduling frequent sessions near the maximum dates of the major meteor showers.

Observations should not be planned for periods less than one hour, as results from shorter intervals have little statistical significance. Work done when the sky is perfectly clear, and in the absence of moonlight and aurora, will probably give the most consistent results. To maintain dark adaptation of the observers' eyes, flashlights used in keeping the records may be covered with red cloth or plastic.

**Coverage of the Sky.** An observer working alone cannot expect to cover the whole sky. He can choose the center of his observing field to suit his convenience, but it should be at least halfway up the sky. His center of vision may be near the zenith if he can lie comfortably on his back.

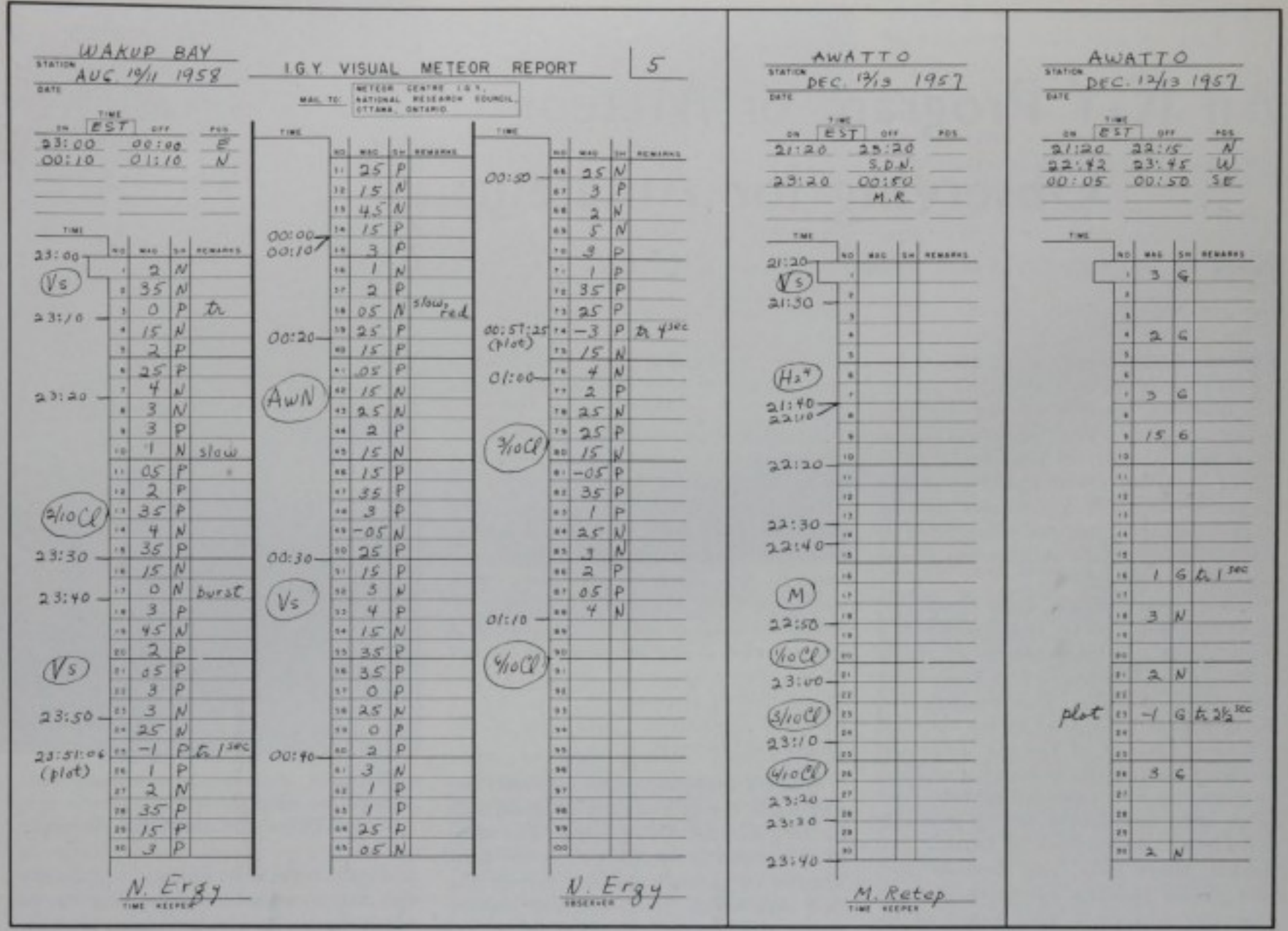
**The trail of a brilliant meteor was caught on this photograph of the region of Orion and the Great Nebula.**

In observing groups, the members should be placed so that their fields of view are distributed uniformly around the sky, centered at points about midway between horizon and zenith. Four observers can obtain fair coverage, but a fifth person is needed to keep time. At Ottawa, we have used eight observers to insure a good comparison between meteors observed visually and by radar.

**Recording the Counts.** Every member of a team will have his own copy of our report form on which to record the magnitude and other details of the meteors he sees. If several members of the group see the same meteor, each should write down his own data, as the comparison of the records gives information about observing errors.

Therefore, each meteor observed from a station is counted only once, regardless of how many observers see it. In other words, the reported total of meteors from a station is a group count. The serial numbers on the report form start with 1 for the first meteor observed by a group each night. The timekeeper keeps a record of the serial numbers by 10-minute intervals, makes notes on the weather, and informs each observer of the serial numbers of the meteors seen. A lone observer acts as his own timekeeper.

Each observer should begin a new sheet




**The first three columns above show a complete report form, as it might be filled out by an observer working alone; at the right are sample columns from the reports of the timekeeper and one observer of a group.**

of the report form each observing night, and sheets are numbered consecutively throughout the month. Sheets from different observers in a group covering the same time period should bear the same serial number. Each observer must record the times at which he begins and ends an *uninterrupted* period of observation. This is important.

Double dates, such as Aug. 11/12, 1957, are needed to designate an observing night unambiguously. Your own zone time is used, expressed on a 24-hour basis with 0:00 at midnight, and no conversion to Universal time should be made.

Ordinary meteors are not to be timed accurately, but only placed within the correct 10-minute interval. Meteors definitely brighter than magnitude 0 should be timed more accurately, if possible, as such objects might be photographed or recorded at other stations.

**Observing Conditions.** Not all observing can be done under ideal conditions. Therefore, we have developed a simple code for remarks on weather and observing conditions, to be inserted in the time column and circled to distinguish them from the time records. Clouds should be indicated by tenths of the sky covered; for haze conditions list the magnitude of the faintest star visible. Auroral light should be described as weak, medium, or bright. If buildings, trees, or hills obstruct an appreciable part of the sky, this should be noted, giving tenths of the sky hidden.

**Magnitudes.** The brightness of each meteor should be estimated to the nearest half magnitude independently by every observer who sees it. These magnitudes are determined by careful comparison with standard star sequences, using only stars that are well above the horizon.

Suitable standard stars are listed here and are plotted on the star maps distributed with our instructions. The planets may be used as bright standards, but their current magnitudes must be looked up in an ephemeris or observing manual, as they change in brightness from month to month.

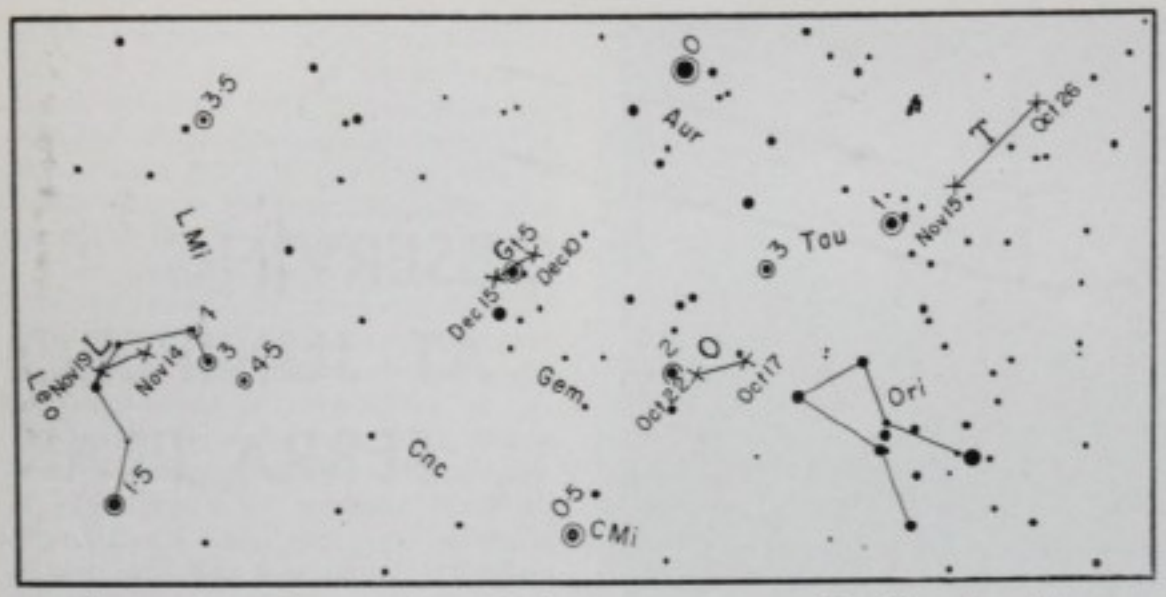
STANDARD-MAGNITUDE STARS

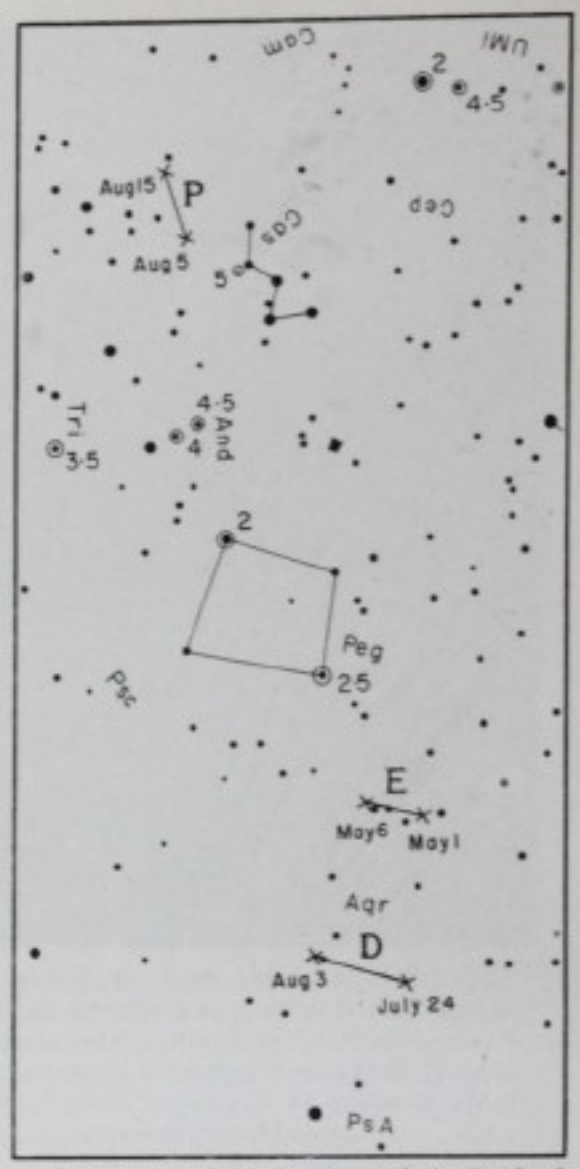
| | |
|---|---|
| −1.5 | Sirius |
| 0 | Capella, Arcturus, Vega |
| +0.5 | Procyon |
| 1 | Altair, Aldebaran |
| 1.5 | Castor, Regulus |
| 2 | α And, γ Gem, α Oph, η UMa, α UMi |
| 2.5 | δ Leo, α Peg, γ UMa |
| 3 | ζ Aql, α CVn, ε Leo, ζ Tau, γ UMi |
| 3.5 | λ Aql, α Tri, λ UMa |
| 4 | μ And, ε Her, μ Leo, χ UMa |
| 4.5 | ρ And, λ Leo, δ UMi |
| 5 | χ Cas, 78 UMa, η UMi |

Estimating brightnesses to the nearest half magnitude may seem difficult at first, but constant reference to the standard stars soon gives the observer confidence and accuracy. The temptation to place all meteors in whole-magnitude classes should be resisted by beginners.

**Shower Meteors.** On certain nights in the year, a large percentage of the meteors observed are traveling along parallel paths through our atmosphere. They are members of one of the annual meteor showers, and their tracks appear to diverge from a place in the sky that is called the radiant. Such showers are usually named after the constellation in which the radiant is located. Most of the important visual meteor showers expected during the IGY are active over several days around the time of maximum given in the table opposite.

When observations are made near the date of a shower maximum, an attempt should be made to decide whether each meteor's trail, if projected back, would




**These sections of two star charts for the Ottawa meteor project show the radiants and their position changes for seven of the showers listed below. The magnitudes of the standard-magnitude stars (circled) are indicated.**

pass through the active radiant. Holding a ruler or straightedge at arm's length, making it coincide with the path taken by the meteor, aids considerably in this observation. A shower meteor is indicated in the column headed "SH" on the report form, with the abbreviation designating the shower to which it belongs. A non-shower meteor is entered as *N*.

Remember that, since the radiant is a perspective effect, shower meteors will have relatively short trails when seen near the radiant. A meteor seen right at its radiant is coming head-on with no apparent motion; it is a point meteor.

**Fireballs.** Meteors as bright as magnitude −2 and brighter are called fireballs, and merit special attention. In such cases, the time should be recorded to the nearest second, if possible, and the apparent path plotted on a star map. If a map is lacking, make a quick sketch of the trail and nearby stars, using the back of the report form. General location in the sky can be indicated by naming the constellations. Include notes on bursts of light, color and color changes, and any persistent train; it is important to record any motion or deformation of a train.

**World Days.** By international agreement, certain periods during the IGY (called world days) have been selected for special effort in all its programs. The corresponding nights are listed here. Although meteor observations will be valuable on any night between June 1, 1957, and January 31, 1959, it is particularly desirable to have as complete a record as possible on the nights indicated.

WORLD-DAY OBSERVATION NIGHTS

| *1957* | | *1958* | | *1958* | |
|---|---|---|---|---|---|
| June | 26/27 | Jan. | *2/3* | Aug. | 6/7 |
| | 27/28 | | *3/4* | | *11/12* |
| | 28/29 | | 18/19 | | *13/14* |
| July | 3/4 | | 19/20 | | *14/15* |
| | *25/26* | Feb. | *9/10* | Sept. | 5/6 |
| | *26/27* | | 17/18 | | 12/13 |
| Aug. | *11/12* | | 18/19 | | 13/14 |
| | 24/25 | | 25/26 | | 19/20 |
| | 25/26 | Mar. | 19/20 | Oct. | 9/10 |
| Aug. | 31 | | 20/21 | | 10/11 |
| -Sept. | /1 | | 27/28 | | 11/12 |
| Sept. | 22/23 | Apr. | 17/18 | | 12/13 |
| | 23/24 | | *18/19* | Nov. | *3/4* |
| | 29/30 | | *19/20* | | 9/10 |
| Oct. | *21/22* | May | *4/5* | | 10/11 |
| | *22/23* | | 17/18 | | *17/18* |
| | *23/24* | | 18/19 | Dec. | 9/10 |
| Nov. | *13/14* | June | 8/9 | | *10/11* |
| | 20/21 | | 16/17 | | *12/13* |
| | 21/22 | | 17/18 | | 16/17 |
| Dec. | *12/13* | | 23/24 | *1959* | |
| | *15/16* | July | 15/16 | Jan. | *2/3* |
| | *20/21* | | 16/17 | | *3/4* |
| | *21/22* | | *26/27* | | 8/9 |
| (Italics denote shower nights.) | | | | | 9/10 |

Astronomical societies and individual amateurs planning to participate in this program can receive instructions and report forms, free of charge, by writing to the Meteor Centre, IGY, National Research Council, Ottawa, Ontario, Canada. The observations they report, as well as the radar data, will be placed on IBM punched cards for statistical analysis. Hence we hope that the results of the program will be available fairly soon after the end of the International Geophysical Year. Progress reports will appear from time to time in astronomical publications.

ANNUAL METEOR SHOWERS

| *Shower* | *Abbreviation* | *Date of Maximum* | *Hour (UT) 1957* | *1958* | *Radiant at Max. R.A.* | *Dec.* |
|---|---|---|---|---|---|---|
| Quadrantid | Q | Jan. 3 | 10 | 16 | 15h 20m | +50° |
| Lyrid | Y | Apr. 22 | 00 | 06 | 18h 12m | +34° |
| Eta Aquarid | E | May 5 | 04 | 10 | 22h 24m | 00° |
| Delta Aquarid | D | July 29 | 12 | 18 | 22h 36m | −17° |
| Perseid | P | Aug. 12 | 07 | 13 | 03h 04m | +58° |
| Orionid | O | Oct. 20 | 19 | 25 | 06h 20m | +15° |
| Taurid | T | Nov. 5 | 19 | 25 | 03h 32m | +14° |
| Leonid | L | Nov. 16 | 18 | 24 | 10h 08m | +22° |
| Geminid | G | Dec. 13 | 12 | 18 | 07h 32m | +32° |
| Ursid | U | Dec. 22 | 17 | 23 | 14h 28m | +76° |

**Reclining chairs and permanent wind screens increase the efficiency of meteor observers at the National Research Council, Ottawa. An improved station is now being built for use during the IGY.**

**The Junipero Serra Peak observing site of the California Academy's Mars expedition. The fork and tube of the 12½-inch Cassegrainian reflector were constructed by George Bunton, the academy's curator of astronomy. The white tube of the 6½-inch refractor is partially visible at the left; in back of it is a fire lookout tower of the Los Padres National Forest. All photographs with this article are courtesy California Academy of Sciences.**

# OBSERVING AT JUNIPERO SERRA PEAK

LEON G. SALANAVE

*California Academy of Sciences**

AS a participating unit of the international Mars patrol, the California Academy of Sciences set up observing equipment on Junipero Serra Peak in Monterey County, California, from August 9th to September 20th last year. This site was described in *Sky and Telescope*, August, 1956, page 469.

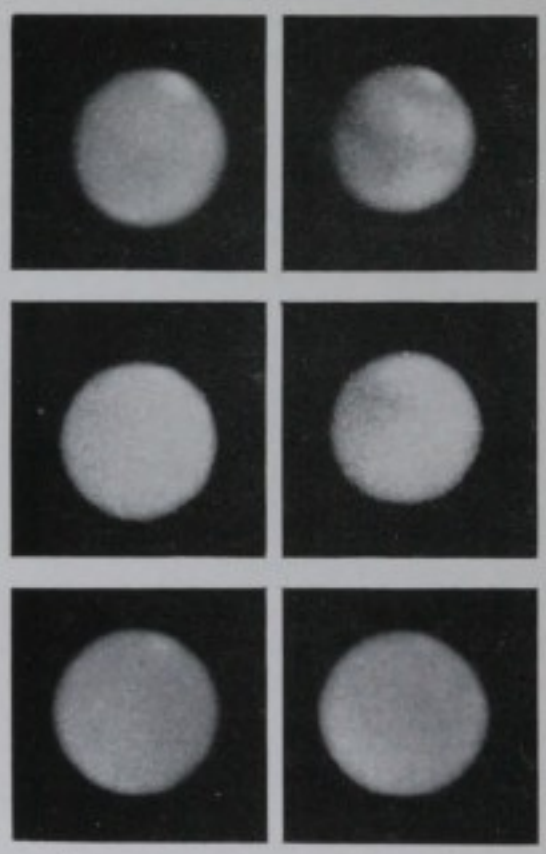
We expected to make photoelectric measurements of the brightness and color of Mars, to photograph the planet's disk in blue and yellow light, and to attempt to measure the drift of clouds over Mars' surface with a filar micrometer. The telescopic equipment included a 12½-inch Cassegrainian reflector with equatorial mounting and clock drive, and a 6½-inch refractor on an altazimuth mounting to be used for seeing tests and photography of the sun.

The writer's special astronomical interest is the sun, and it was the possibility that Junipero Serra Peak might offer advantages as the site of a solar observatory that sent me on my first expedition to this mountain, in May of 1955. The Mars patrol offered a good opportunity to test the quality of atmospheric seeing on the peak during both the day and night. As the accompanying picture of solar granulation and the front-cover photograph show, the results of these tests were very encouraging. They have been reported to the Phoenix field office of the National Astronomical Observatory for consideration of the peak as a possible instrument site.

When the seeing at night was good, the refractor gave some excellent views of planetary detail. For instance, about 1 o'clock in the morning on August 20th the seeing was nearly perfect; at 500x with the 6½-inch, stellar diffraction rings were almost complete. According to the criteria set up by Danjon and Couder (*Lunettes et Telescopes*, Chapter 5), this would indicate an atmospheric turbulence of 0".2. Under these conditions, I recorded in the observing book, "Mars at 350x showed much *spotty* detail, no 'canals' or any suggestion of sharp features. No clouds in blue or yellow."

On the morning of September 3rd, about 0:30 Pacific standard time, the following was noted: "Seeing excellent; turbulence less than 1". Blue versus yellow filters showing no evidence of clouds. *Very little dark detail* in spite of good seeing. Disk sharply defined but no fine detail." I was struck by the fact that the polar cap, so very conspicuous only a week before, was now almost undetectable. These observations are, of course, independent evidence of the great general cloudiness that formed on Mars at the end of August, as reported by other observers of the planet.

The photographic results were better than expected, for detail on the planet was recorded with an image only two millimeters in diameter. The equivalent focal length of the Cassegrainian was about 12 feet; at opposition this alone would have given a Martian image of not quite half a millimeter. By means of an enlarging camera equipped with a coated lens of 50 millimeters focal length, the planetary disk was increased to two millimeters. Without a filter, 1/10 second was



**Junipero Serra photographs of Mars in blue light (left) and in yellow light (right). The top pair was taken on August 22, 1956, when Mars' central meridian was at longitude 280°; the polar cap is prominent and Syrtis Major appears as a dark triangle in the yellow exposure. But on September 7th, the planet's surface was covered with yellow clouds, as the middle pair shows, longitude 90°. The bottom pair was taken September 13th, central meridian longitude 30°. These prints have been enlarged nine times.**

*Mr. Salanave has recently become associated with the national optical observatory project, sponsored by the National Science Foundation, with its headquarters at Phoenix, Arizona.

sufficient exposure time on Panatomic X film, but this had to be increased to $\frac{1}{3}$ second in yellow light (Schott filter GG 14), and to one second in blue light (Schott filter BG 12). The image was focused with a 10-power magnifier and ground glass in the camera's focal plane.

Three pairs of photographs of Mars in blue and yellow light, taken August 22nd, September 7th and 13th, are enlarged here about nine times. The first pair has the usual difference in the rendition of surface detail, while the polar cap is clearly seen on both pictures. But the cloudiness of early September rendered Mars' atmosphere almost as opaque to yellow as to blue light; this is indicated by the lack of detail in the yellow images, which are otherwise sharp and well defined. Thus, both photographic and visual observations indicate that, rather than speaking of a blue clearing, we may have to refer to a "yellow hazing" of Mars in 1956!

The picture below shows the setup for solar photography. A Herschel wedge was used to discard about 95 per cent of the sun's light and heat, the remainder being reflected upward through an orthoscopic eyepiece of 17 millimeters focal length that enlarged the sun's disk to a diameter of 12 inches. Only a part of this image could be recorded on $2\frac{1}{4}$-by-$3\frac{1}{4}$-inch film. Eastman Contrast Process Ortho was used, with development in DK50. A Wratten G filter restricted the light to a narrow region in the yellow part of the spectrum, making the image practically monochromatic and thus minimizing chromatic aberration.

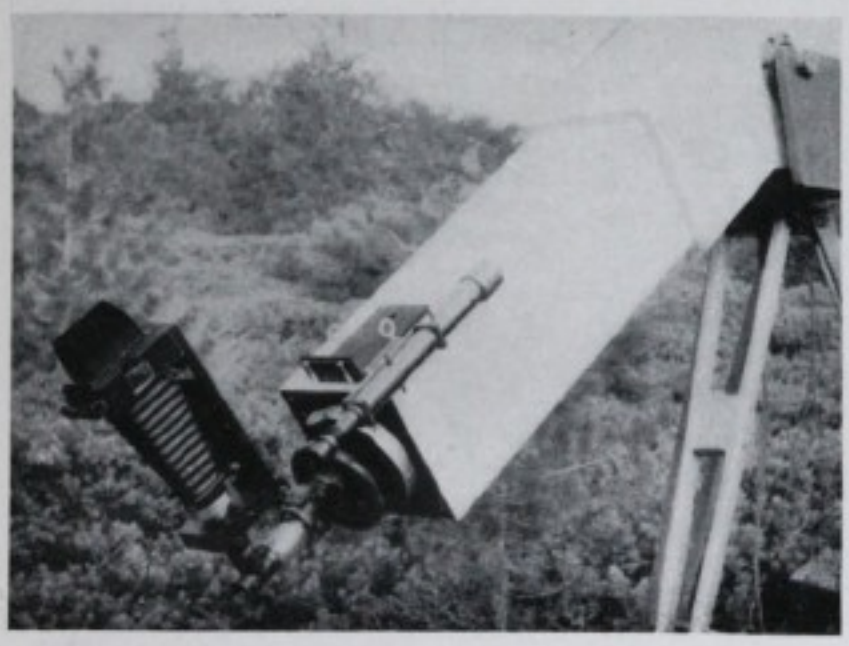
Using this arrangement, the sun could be photographed with an exposure of 1/250 second, the objective being used at its full aperture of $6\frac{1}{2}$ inches, to retain maximum resolving power and sensitivity to seeing conditions. An exposure of 1/500 second would have been better, but the camera's Compur shutter did not have this speed.

From August 9th to September 17th, 54 exposures were made on the sun's limb or disk. Usually a pair was attempted, one on the limb to show the effects of atmospheric rippling, and one on some well-developed sunspot to record the degree of definition in penumbrae, as well as the granulation of the photosphere.

**Extremely fine details in sunspot penumbrae, as well as the granulation of the photosphere, show in this picture taken on September 12th at 7:45 a.m. Pacific standard time. The exposure time was 1/250 second. The scale of the $3\frac{1}{2}$-times enlargement is about 0.6 millimeter to one second of arc. This picture and the front-cover photograph illustrate the kind of daytime seeing that astronomers look for in selecting the site of a solar observatory.**

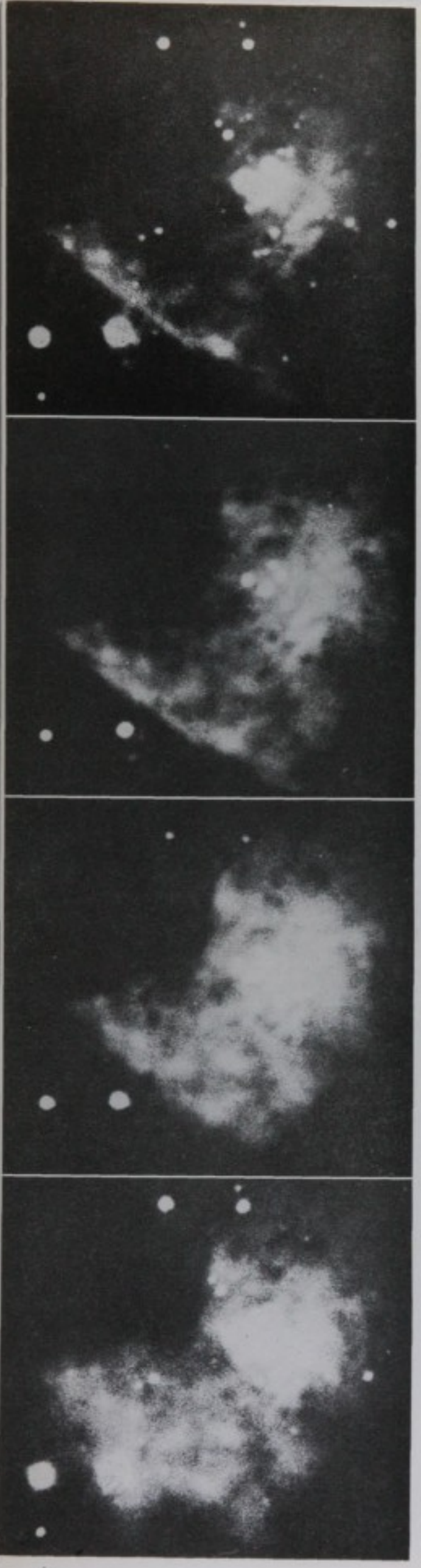
Prevailing summer breezes off the ocean 12 miles away bring clean air to Junipero Serra Peak. Very often during the expedition there was no visible aureole around the sun, a condition that once prevailed for two days. Seeing was usually good, and frequently excellent. Visibility of the fine solar granulation structure occurred often—at least momentarily—during visual observations made between one and two hours after sunrise.

Such granulation was well defined, with pores approximately $\frac{3}{4}$ second of arc in diameter clearly visible at 200x. It is roughly estimated that this quality of seeing prevailed at least one per cent of the time, that is, for four hours of "one-second" seeing spread out through the six-week period.



Above: The enlarging camera for solar photography, attached to the $6\frac{1}{2}$-inch refractor on an altazimuth mounting. The same objective lens and solar attachment were used in 1880 by George Davidson, to observe an eclipse of the sun from this same peak, then known as Santa Lucia Mountain.

Right: While Fred Tuttle, the mountain's fire warden, sights through the 3-inch guide telescope, the author is looking at Mars through a focusing eyepiece in the plate slide. To obtain the best pictures, the observer pushed the cable release only when Mars' image was steady, as seen with 100x through the guide telescope.



# Some Recent Work on the Orion Nebula

OTTO STRUVE, *Leuschner Observatory, University of California*

DURING the past few years, several important advances—both observational and theoretical—have been made in our knowledge of the Orion nebula's structure, as well as of the physical processes that produce the light of this vast chaotic mass of fluorescent gas. Of special interest are two papers under the joint authorship of K. Wurm, from the Hamburg-Bergedorf Observatory, West Germany, and L. Rosino, at the Asiago Astrophysical Observatory in Italy.

Since the war, Dr. Wurm has been building new light filters of the liquid-dye type and studying their properties. In the Orion nebula program, each filter was designed to transmit a specific emission line or chosen region of the continuous spectrum. The photographs were taken with the 47-inch reflector at the Asiago Observatory's branch station at Loiano, in the Italian Alps. Other filter work was done with the Hamburg Observatory's 14-inch Schmidt camera, which was moved to Asiago in October, 1955.

Half a dozen liquid-dye filters were employed in the Orion observations, each having an over-all thickness of about 3/8 inch and containing a layer of liquid of about 1/5 inch. The filters were placed in front of the photographic plate, and for the Schmidt camera's large field the filter diameter was about four inches. The half widths of the passbands ranged from 100 to 200 angstroms.

The most satisfactory results were obtained with the four filters that yielded the photographs reproduced here. Two of these filters transmitted red light: one the forbidden line of ionized sulphur at 6730 angstroms, the other the hydrogen-alpha line at 6563 and the adjoining forbidden line of ionized nitrogen. A third passed the intense green emission line of doubly ionized oxygen at 5007, while the fourth recorded the continuous spectrum in a region around 5200 angstroms.

**Fig. 1. The central region of the Orion nebula, photographed in different colors at the Asiago Observatory. From top to bottom, the spectral regions are: 6730 angstroms, ionized sulphur; 6563, hydrogen alpha and ionized nitrogen; 5007, doubly ionized oxygen; and the continuous spectrum at 5200 angstroms.**

The pictures show only the inner region of the Orion nebula, recorded easily in exposures of up to 15 minutes. Prints of less density form the series at the left (Fig. 1), those of higher density the set at the right (Fig. 4); they are all from the same four negatives. In some, the four stars of the Trapezium may be seen. Brightest of these is an object of spectral type *O*, a very hot star whose ultraviolet light is mostly responsible for the fluorescent radiation of the nebula. Another bright star, to the lower left in the photographs, $\theta^2$ A Orionis, is also of type *O*, and probably contributes to the light of the nebulosity.

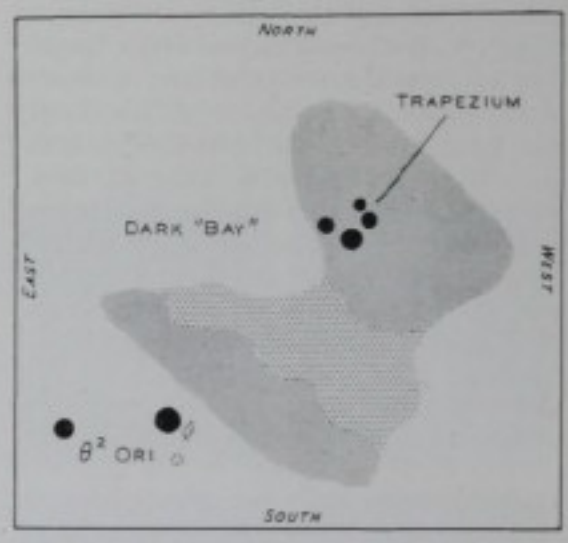



**Fig. 2. A key chart for the eight pictures of Figs. 1 and 4. The scale is large, for the components of $\theta^2$ Orionis are 52 seconds of arc apart; near one component are indicated the circular and elliptical knots referred to in the text. The Trapezium shows best in the hydrogen-alpha photograph, second from the top in Fig. 1.**

In all four cases, the brightest nebulosity is immediately southwest of the Trapezium. Another region of high surface brightness is located toward the southeast, in the vicinity of $\theta^2$ Orionis. But the four pictures are not alike. In the light of sulphur and of hydrogen, the region between the Trapezium and $\theta^2$ Orionis is relatively faint. This gap is hardly no-

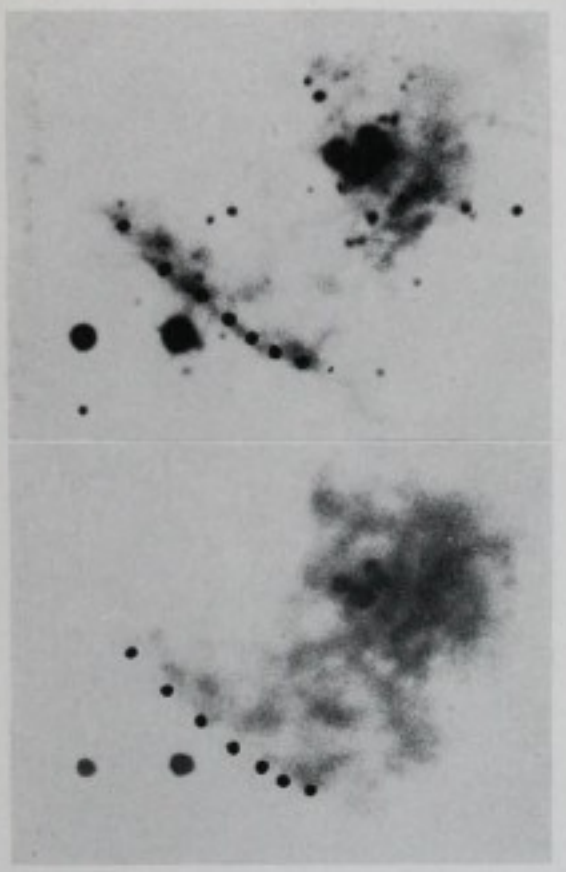


**Fig. 3. A comparison of the positions of nebulous knots in sulphur and oxygen. These are negative prints, luminous matter appearing dark. Asiago Observatory photographs.**

ticeable in the doubly ionized oxygen picture, while the exposure in continuous radiation near 5200 angstroms resembles that in oxygen light more than it does either of the other two.

As other observers, both visual and photographic, have noted previously, these inner parts of the nebula have a spotty or mottled appearance. It is remarkable that the most pronounced of the bright knots can be identified in every picture, regardless of the different elements that are involved. The positions of these patches seem to be the same in all, which must mean either that the knots are regions of increased density within the nebula, or that they are caused by thin areas in absorbing clouds in front of a fairly uniform luminous background.

However, there are notable exceptions to the general similarity of the photographs in the four wave lengths. Wurm and Rosino call attention to two small knots; one immediately to the south of $\theta^2$ Orionis is roundish and may have a star at its center; the other is to the west of $\theta^2$ Orionis and is elongated. Both can best be seen in the sulphur and hydrogen exposures of Fig. 4, while they are hardly visible in oxygen or continuous radiation.

Especially noteworthy is the sharp, nearly straight edge of the nebula northwest of $\theta^2$ Orionis. In the light of sulphur and hydrogen, the condensations in this border are elongated from northeast to southwest, that is, along the border itself. In the rest of the nebula the knots are more nearly circular. It seems as though the sharp edge of a dark cloud lies southeast (on the side toward $\theta^2$ Orionis) of the luminous border observed in sulphur and hydrogen. If the dark cloud is at the same distance from us as the luminous rim, the latter could be regarded as one of the "silver linings" frequently observed in gaseous nebulae (see *Sky and Telescope*, August, 1951, page 244).

J. H. Oort was the first to explain such luminous rims as resulting from a collision of highly ionized gas (moving to the southeast in the case of the Orion feature) with a relatively cool and dark stationary cloud. The collision forms a narrow rim of increased density at the boundary between the two clouds, where the ionization is reduced, but the surface brightness should be increased in the light of those elements whose atoms are still mainly in ionized form.

This prediction is strikingly confirmed in Fig. 3. Wurm and Rosino have marked in the upper picture seven conspicuous knots observed in the light of sulphur. These same dots have been transferred to the oxygen picture below, showing at once that the region of high ionization containing doubly ionized oxygen does not extend as far to the southeast as that emitting light from the more easily ionized sulphur. Clearly, then, the strip of the nebula nearest the dark cloud is less highly ionized than are the layers located farther from the interface. The bright and dark nebulosities involved in this interaction would appear to be at the same distance from us, lying side by side.

On the other hand, the dense dark matter lying east of the Trapezium does not show the bright-rim phenomenon. Its right-angle edge is in the same position on all four photographs. We can conclude that this dark cloud or "bay" lies closer to us than the luminous material west of it—there is no collision and hence no abrupt increase in density or luminosity along the apparent edge of the bright mass.

Wurm and Rosino call attention to the fact that this dark cloud hides part of the well-known cluster of stars whose nucleus is the Trapezium. They note that this cluster probably occupies the same volume in space as the central part of the nebula. They point out the gas density of this central region is very high, some 10 times that of the Orion nebula as a whole. It is the much larger region of low density that we are accustomed to seeing in long-exposure photographs of this object. In such pictures the details of these central regions are simply drowned out by the light from the surrounding material.

We have already noted that the Orion nebula photographed in continuous light resembles the doubly ionized oxygen pictures more than it does hydrogen photographs. This is also shown in an earlier

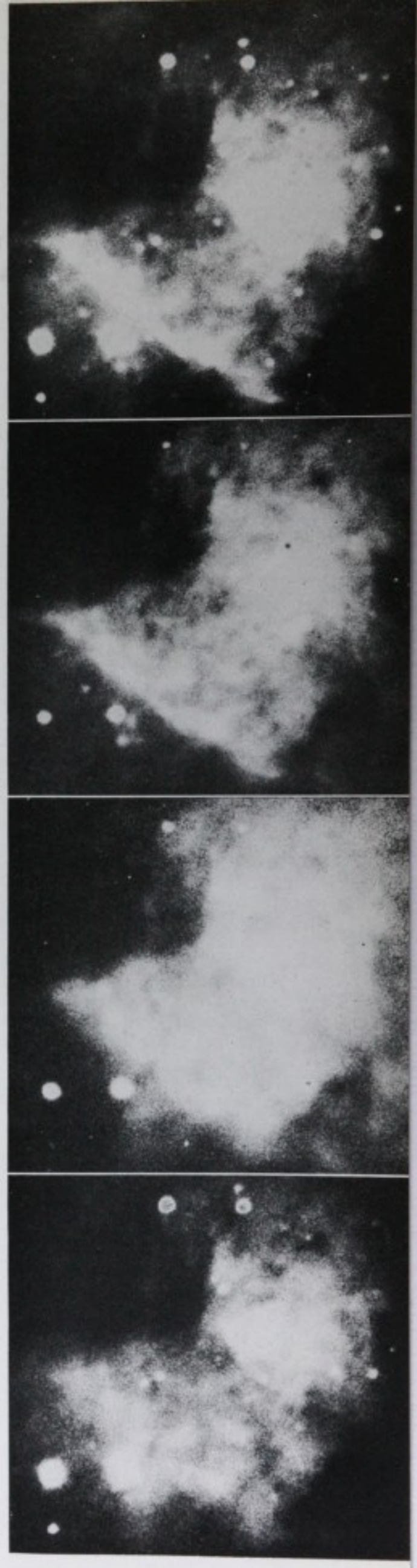


**Fig. 4. These are the same part of the Orion nebula and at the same wave lengths as in Fig. 1, but here the prints have greater density.**

**Fig. 5. The spectrum of the Orion nebula, photographed by J. L. Greenstein at the McDonald Observatory, with the 82-inch reflector. Above and below the nebula's spectrum are laboratory comparison spectra to provide scales for wavelength measurement. The continuous background of the nebula spectrum to the right of the Balmer limit is unexpectedly strong. The Balmer continuum is in the ultraviolet, to the left of the limit.**

study by Wurm and Rosino of the outer parts of the nebula. At nine different points near its borders they measured the relative surface brightnesses in continuous light (around 5200 angstroms), in the hydrogen-alpha and hydrogen-beta lines, and at 5007 angstroms for doubly ionized oxygen.

They found a wide variation in these relative brightnesses from place to place. Some points were twice as bright in hydrogen-alpha as a reference point, but about two times fainter than the reference in continuous light. In one case, the hydrogen-alpha and continuous-light brightnesses were both only half that of the reference. There was no correlation, therefore, between the continuous and hydrogen surface brightnesses, and only a very slight correlation between the continuous and oxygen intensities. (Wurm and Rosino do not attribute significance to this continuum-oxygen correlation, for they believe some oxygen emission manages to pass through their filter for continuous light, and, of course, some of the continuous light passes through the oxygen filter.)

This result has interesting consequences, because it upsets the belief of most previous investigators that the continuous light of the nebula is largely produced by hydrogen atoms. To understand why this belief was held, let us examine some characteristics of the spectrum of the Orion nebula reproduced here by courtesy of J. L. Greenstein (Fig. 5).

Conspicuous at the extreme right, in the green region of the spectrum, are the lines of doubly ionized oxygen, and next to them is hydrogen-beta, at 4861 angstroms. Some other lines are prominent, including higher members of the Balmer series of hydrogen. There is also a pronounced underlying continuous emission spectrum, strongest to the violet of the Balmer limit, where it is designated as the Balmer continuum. This continuous emission over a broad range of wave lengths in the ultraviolet is caused by the captures of free electrons by protons (hydrogen nuclei).

All emission lines of the Balmer series arise from the release of energy as an electron drops to the second lowest level it may occupy in the hydrogen atom. The hydrogen-alpha line, representing the least energy change in the series, is produced when the electron drops from the third level to the second; hydrogen-beta is produced by a fall from the fourth level to the second, and so forth. Thus, the limit of this Balmer series of spectral lines corresponds to the energy released by an electron falling to the second level from an infinitely high level—that is, from outside the atom.

But if such a free electron has kinetic energy of its own, some of this will also appear as radiation, and the wave length of the emission may have any value shorter than the Balmer limit at 3646 angstroms. The Orion nebula contains an enormous number of protons and equally many free electrons. The latter have all possible velocities relative to the protons; hence, their captures into the second orbits of the different protons will cause a superposition of countless emission lines, all at different wave lengths to the violet side of the Balmer limit. What we observe with a spectrograph is a continuous spectrum extending from the Balmer limit toward the ultraviolet.

Yet why is the underlying continuous spectrum also quite conspicuous on the right-hand (red) side of the Balmer limit? We would expect only the well-known discrete lines of the Balmer series itself. As Fig. 6 shows, however, there is another series of lines in the infrared region of the spectrum, which is produced by the fall of electrons into the third energy level of the hydrogen atom. The lines of this Paschen series fall closer and closer together to a limit at 8206 angstroms, in the infrared, and the Paschen continuum extends to the left of this limit, into the visible region of the spectrum.

However, the Paschen continuum fades

**FACING PICTURE: The region of Orion's sword, showing M42 and M43 blended together to form the Great Nebula, with the nebula NGC 1977 at the top (north) and the star Iota Orionis at the bottom. The Trapezium and other details in the central portion of the Great Nebula are overexposed in this two-hour exposure with the 36-inch Crossley reflector. It was taken January 17, 1939, by N. U. Mayall. The reproduction scale is about 7.7 minutes of arc to the inch. Lick Observatory photograph.**

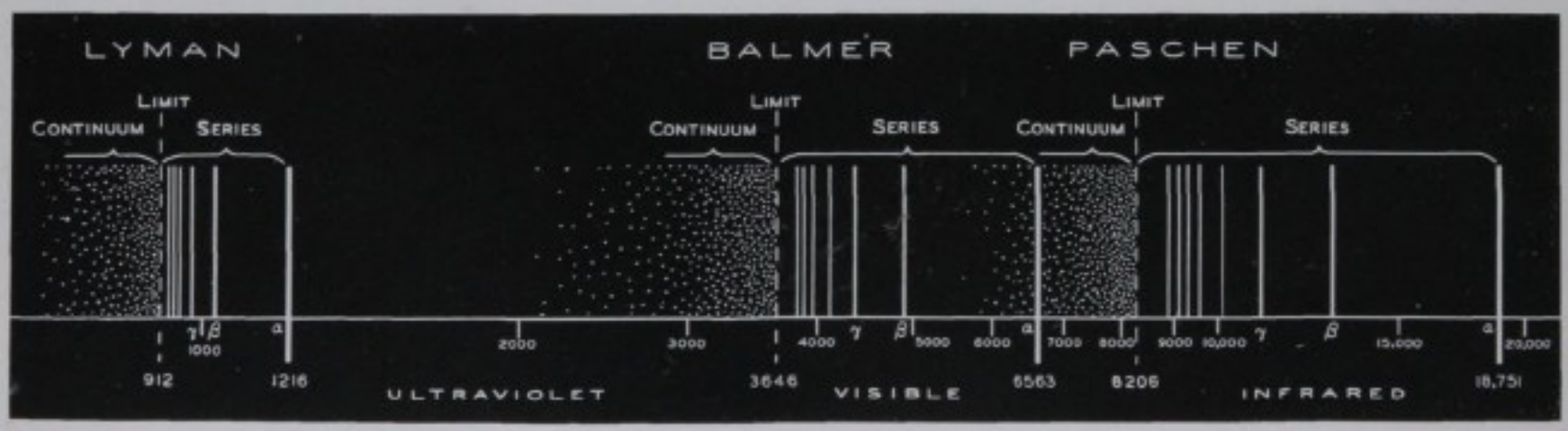



**Fig. 6. Three series of lines in the spectrum of the hydrogen atom and their respective continua are shown here. The series lines are named with lower-case Greek letters, for instance, α, β, and γ in the Lyman series. Wave lengths are indicated in angstrom units, the Paschen-alpha line being at 18,751 angstroms; the scale itself is drawn logarithmically, as the series are of very unequal extent on a linear scale. The atmosphere shields the earth's surface from radiations of less than about 3000 angstroms (in the Balmer continuum), but rocket-borne instruments have recorded the sun's spectrum even in the Lyman region of the far ultraviolet.**

rapidly with decreasing wave length, and is quite insignificant near the Balmer limit. Therefore, while the continuous spectrum on the ultraviolet side of the Balmer limit should be very strong, it should have practically zero intensity on the long-wave side. Yet, in the Orion nebula we observe the continuum to be strong on both sides of the Balmer limit. We must conclude that the entire observed continuous spectrum is not merely a superposition of a Paschen and a Balmer continuum, and that only the *increase* in intensity on the ultraviolet side of the Balmer limit can be explained by free electron captures.

Fig. 6 shows that there is also an ultraviolet emission series resulting from electron drops to the lowest energy level of the hydrogen atom. Lyman-alpha, at 1216 angstroms, is produced when an electron falls from the second orbit to the first or lowest one. The Lyman continuum, on the short-wave side of 912 angstroms, results from captures of free electrons into the first orbit.

Suppose that an electron has already been captured into the second or Balmer level. If the atom is otherwise undisturbed, this electron would normally remain in this orbit for about $10^{-8}$ second of time, then would automatically fall into the first orbit with the emission of Lyman-alpha radiation. Although this line is not observed in stellar spectra because the earth's atmosphere is opaque at such a short wave length, Lyman-alpha must be of tremendous intensity in all gaseous nebulae.

It was 1929 when a German physicist, Maria Goeppert Mayer, pointed out that hydrogen atoms can produce another kind of continuous spectrum than the Lyman, Balmer, Paschen continua. The necessary condition is that the gas be of exceedingly low density. M. J. Seaton and others have suggested that this process, called two-photon emission, may be of astrophysical importance in gaseous nebulae.

Consider an electron in the second orbit, about to make the jump to the lowest orbit that would normally result in Lyman-alpha emission. Instead of making a single jump, however, it first drops to an intermediate stage, then almost instantaneously goes the rest of the way. The halt can be anywhere between orbits 2 and 1 (Fig. 7), but neither photon emitted by this process can have the energy of Lyman-alpha; both must be on the long-wave side of that spectral line.

Some atoms thus might first emit relatively long-wave light; others would produce two successive photons of about the same wave length; and still others might emit first an ultraviolet line and then one of much longer wave length. As with the captures that make the series continua, the observed spectrum would be a superposition of innumerable lines, producing a glow in the region to the right of the Lyman-alpha line and extending even to the red of the Balmer limit.

If these two-photon transitions were responsible for the observed continuous spectrum of the Orion nebula, we should certainly expect that portions of the nebula especially bright in hydrogen-alpha light would also be bright in continuous radiation. But this is not the case, and Wurm and Rosino could find no such correlation. Their interpretation is that the two-photon type of emission does not make any great contribution to the continuous light of the Orion nebula.

What, then, is the real origin of the continuous spectrum of this object? It may well be that we shall have to return to the oldest hypothesis of all—that it is caused by the scattering of starlight from solid particles such as dust or interstellar meteoroids.

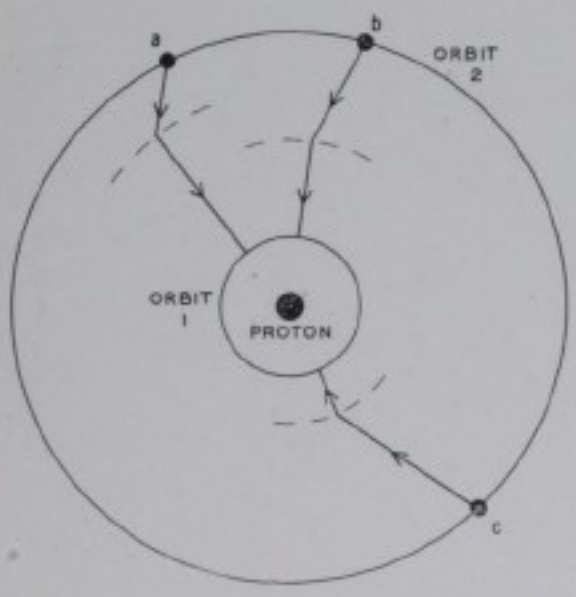



**Fig. 7. Under exceptional conditions two-photon transitions can occur, such as the three cases shown here. Instead of jumping directly from orbit 2 to orbit 1, the electron halts briefly between, so that two photons are emitted instead of one.**

## QUESTIONS... FROM THE S+T MAILBAG

**Q.** Is it all right to keep a telescope in the house and take it out for immediate use?

**A.** Keeping the telescope indoors while it is not in use is all right, and owners of portable instruments generally do this. But if the outside air is cold, there will be a change in the telescope's performance while it cools off, so many observers let their instruments stand for some minutes before starting to use them.

**Q.** Exactly when does daytime begin?

**A.** By definition, daytime begins when the upper edge of the sun appears on the horizon; similarly, daytime ends when the upper edge of the sun disappears.

**Q.** I have never seen a complete list of Herschel star clusters and nebulae, analogous to the list of Messier objects. Is there a book or manual containing such a list?

**A.** Sir William Herschel's designations are no longer used by astronomers, although they are still occasionally seen, for instance in Norton's *Star Atlas*. J. L. E. Dreyer's *New General Catalogue of Clusters and Nebulae*, which lists objects by their NGC numbers, also gives the corresponding Herschel numbers.

**Q.** What are the Galilean moons of Jupiter?

**A.** They are the four largest, and by far the brightest, of Jupiter's 12 satellites. Discovered in 1610 by Galileo, they are usually referred to as **I, II, III,** and **IV,** in the order of increasing distance from the planet. The corresponding names are Io, Europa, Ganymede, and Callisto.

**Q.** What is the astronomical unit?

**A.** It is a unit of length, very nearly equal to 93 million miles, defined as the mean distance of the earth from the sun.

**Q.** What are the zodiacal constellations and what are the symbols used to designate them?

**A.** The 12 zodiacal star patterns form the background against which the sun, moon, and planets appear to move. Their names and symbols are:

| | | |
|---|---|---|
| Aries ♈ | Leo ♌ | Sagittarius ♐ |
| Taurus ♉ | Virgo ♍ | Capricornus ♑ |
| Gemini ♊ | Libra ♎ | Aquarius ♒ |
| Cancer ♋ | Scorpius ♏ | Pisces ♓ |

**Q.** Can I use an astronomical telescope on my boat this summer?

**A.** A low-power, hand-held instrument should give good results, if the water is calm and the boat does not roll or pitch appreciably. A rich-field telescope might be very satisfactory.

**Q.** Why are the largest telescopes of the reflector type?

**A.** For an aperture above about 40 inches, the weight of the glass in the lens of a refractor causes excessive bending of the objective, and the thick glass absorbs too much light. The mirror of a reflector can be supported from behind to minimize the effects of flexure, and the light does not pass through the glass.

**Q.** What is the average velocity of the earth in its orbit, and how much does it change during the year?

**A.** The earth revolves around the sun at an average rate of 18.5 kilometers per second, or 11.5 miles per second. At perihelion the earth's velocity is 1.7 per cent more than this, at aphelion it is 1.7 per cent less.

**Q.** About 50 years ago William H. Pickering published a lunar atlas. Where can this book be obtained?

**A.** His *Photographic Atlas of the Moon*, 1903, forms Vol. 51 of the Harvard Observatory *Annals*, but is out of print. However, it may be found in observatory libraries and in many large public libraries. W. E. S.

# Visual Aurora Observing During the IGY

D. S. KIMBALL, *Yale University Observatory,* and C. W. GARTLEIN, *Cornell University*

THE SUN is continually ejecting fast-moving electrons and positively charged atoms into interplanetary space, where some of them encounter the earth. This thin rain of electrified particles in the upper atmosphere produces the aurora. Guided by the earth's magnetic field, these particles fall mostly into two zones centered on the north and south magnetic poles. The aurora plays a key role in the study of solar-terrestrial relationships; its behavior is closely associated with sunspots, magnetic storms, and changes in the earth's ionosphere.

Ordinarily auroral displays are observed only in high northern and southern latitudes, but occasionally they become visible in places far beyond the usual limits. One of the greatest and most beautiful of these was on September 1, 1859, seen from the polar regions to as far south as Hawaii. Another major display, on February 4, 1872, was visible from many places in low latitudes: the West Indies, Guatemala, India, and Arabia, among others.

Auroral observations will be an important part of the world-wide co-operative study of our planet during the International Geophysical Year. In regions where displays are especially frequent, for example southern Canada and the northeastern United States, the studies will be primarily instrumental. Systematic photographs will be taken with all-sky cameras. Radar apparatus, several types of spectrographs (see *Sky and Telescope,* March, 1957, page 213), and other specialized equipment will also be used.

In regions where auroras are less common, much reliance will be placed on visual observations. In an integrated North American program, data from weather stations and from many volunteer observers will be combined into synoptic maps, showing the geographical locations of auroras, their changes, colors, and other properties, as already noted on page 159 of the February issue.

**Auroral Forms.** The varied features that may be seen during an auroral display are conveniently sorted into a few classes, portrayed in Fig. 1 and Fig. 2, which are in international use. Gaining familiarity with these auroral forms is a first step for amateurs who wish to take part in the IGY program and, indeed, for anyone who makes observations of the phenomenon. The following descriptions are considerably condensed from our instruction sheets.

Commonest of the forms of the northern lights is the *glow* (*G*), a faint, quiescent luminosity. Seen near the northern horizon, it resembles the dawn; when high in the sky it is like a translucent veil. The glow occurs alone only at the beginning and ending of a display; often a conspicuous display will close in a glow that may persist for several hours.

*Patchy aurora* (*S*) consists of spots or patches of diffuse light, whose borders are better defined than the edge of a glow. This form is usually whitish, but may be a deep red.

The *homogeneous arc* (*HA*) appears as a segment of a circle across the sky, usually nearly at right angles to the meridian. The lower edge is more sharply defined than the upper, but no fine structure is apparent. It may be low or high in the heavens; below the arc the sky is sometimes very dark, forming the so-called dark segment. When several arcs are seen they are closely parallel.

If an arc has folds or kinks in it, it is known as a *homogeneous band.* It may move east-west with an undulating motion, or it may oscillate in a north-south

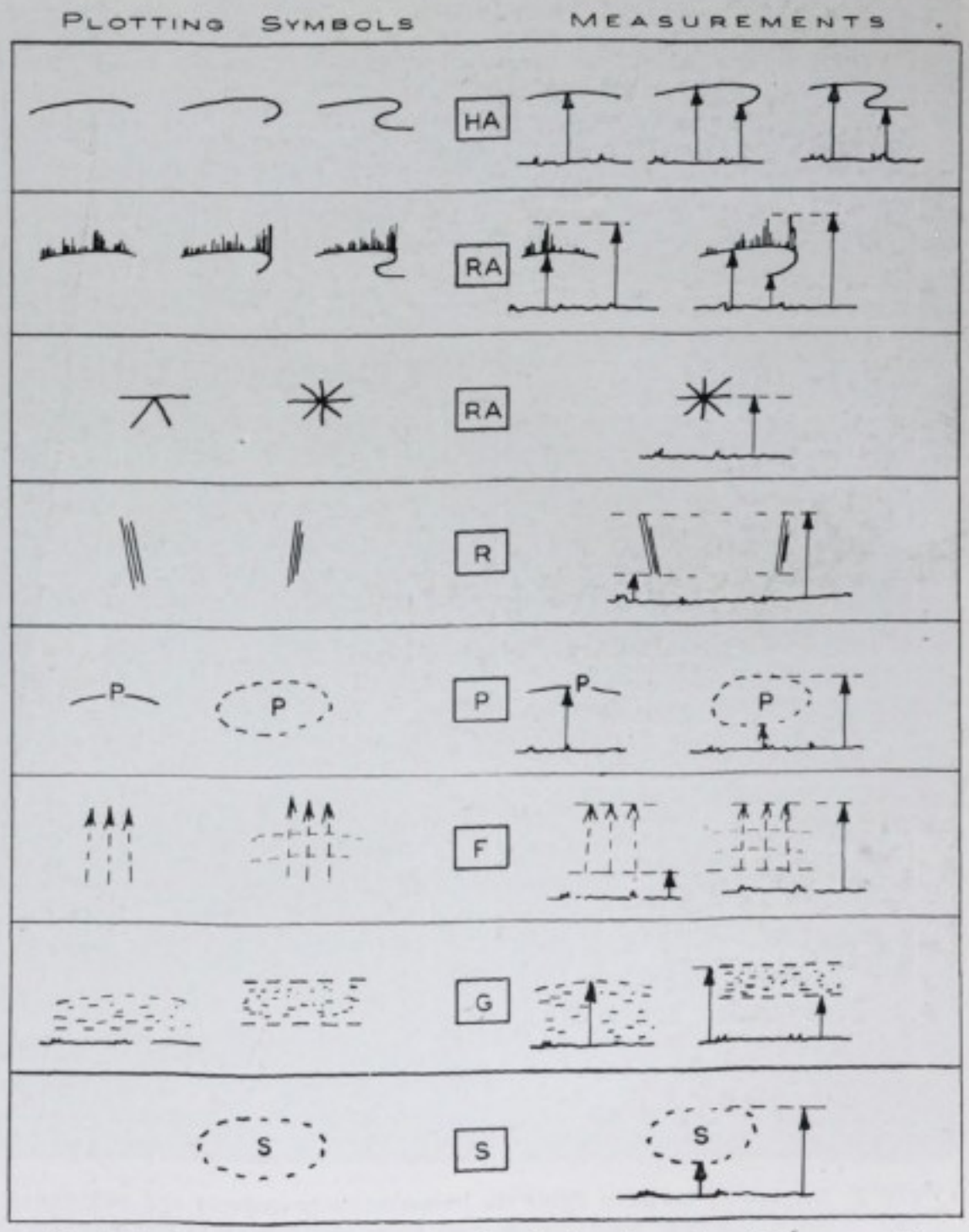



**Fig. 1. At the left are symbols to use for plotting the various features on the data report cards. At the right, the arrows indicate the parts of the auroral forms for which altitude measurements should be taken.**

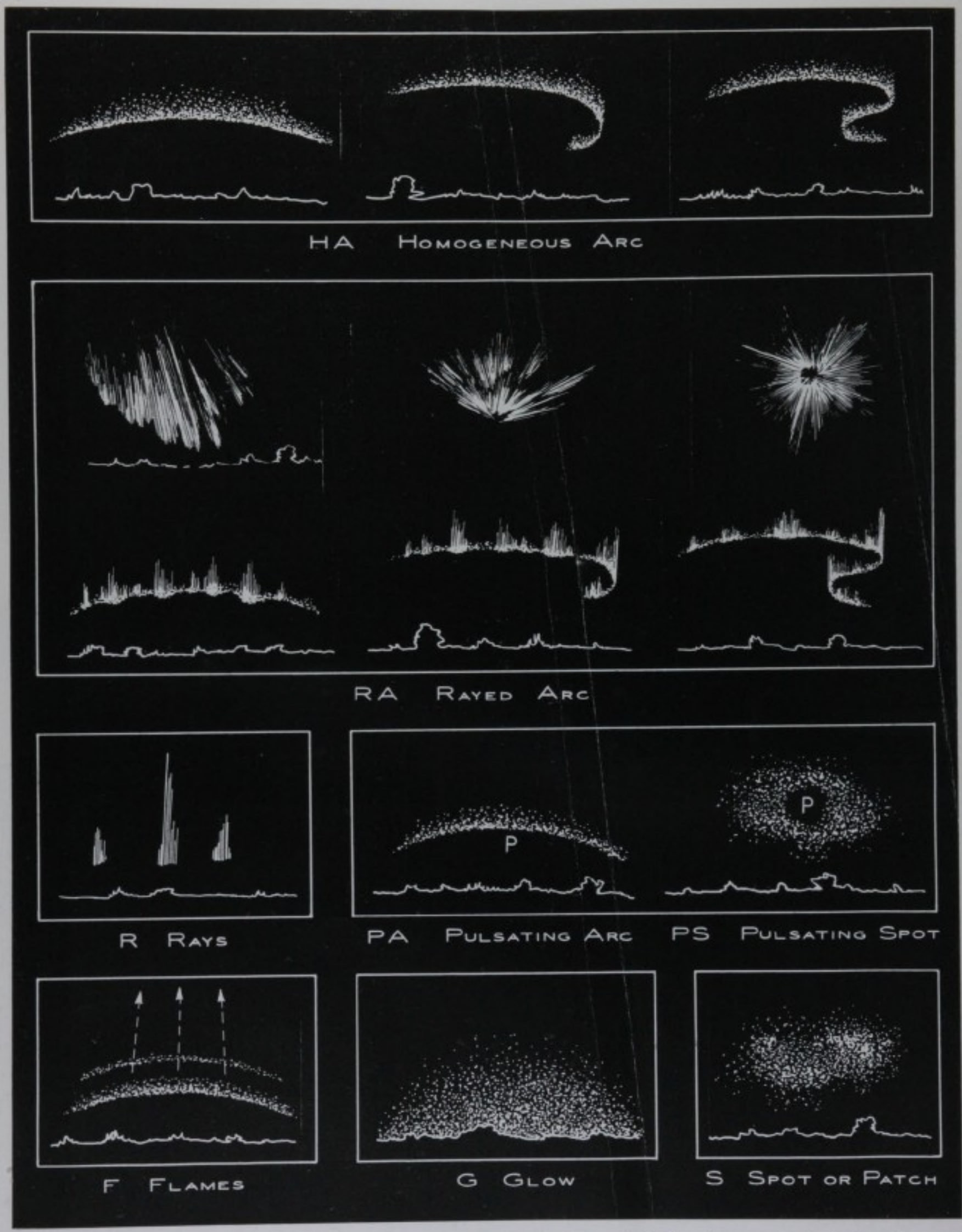



Fig. 2. Displays of northern lights are becoming more frequent and widespread during the current period of maximum solar activity. Amateur observers can gain fuller appreciation of this beautiful phenomenon by having some acquaintance with the typical forms and their usual sequence in a display. These sketches are a key for identification of the principal auroral features. The abbreviations given are those in general use for auroral reporting. In the group of rayed arcs, the corona is depicted in the upper right. Beneath the other sketches, a jagged line represents the observer's horizon.

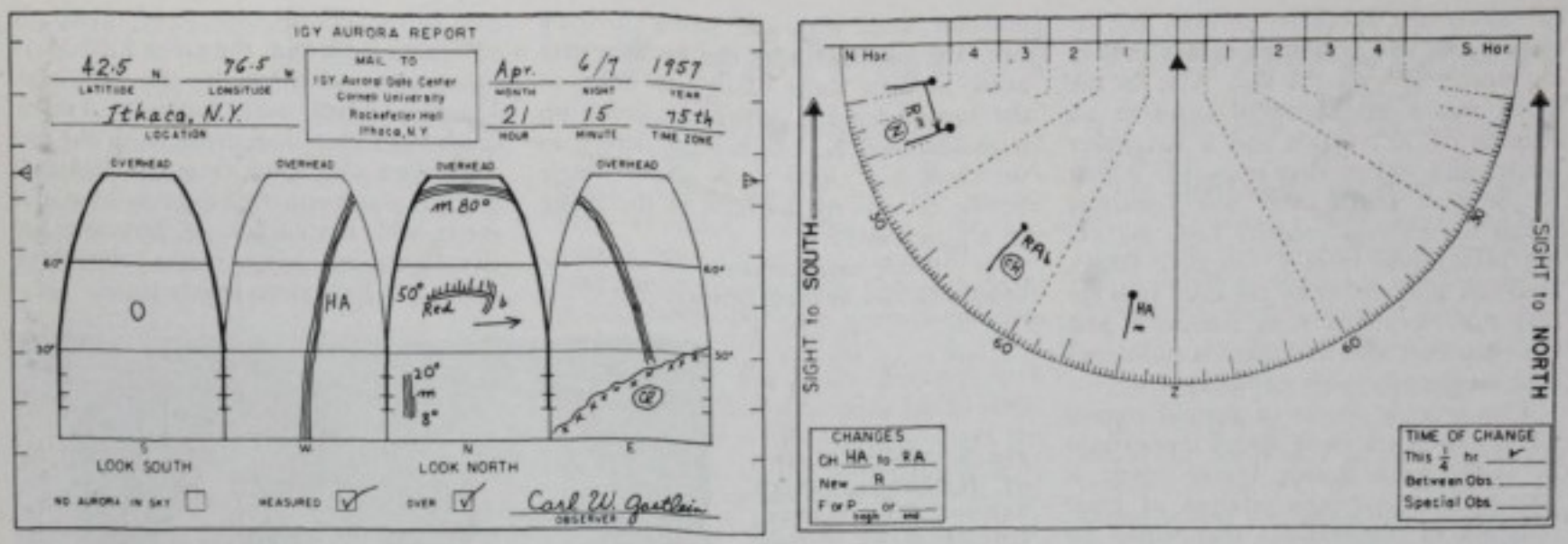



**Fig. 3. The front and back of a reporting card are reproduced at somewhat over half original size. They have been filled in to demonstrate the simplicity of this method of describing an aurora.**

direction. The arc may become very bright or have a red lower edge; it may suddenly change into ray forms.

The *rayed arc* (*RA*) resembles the homogeneous arc in shape, but is composed of rays standing side by side, perpendicular to the length of the arc. If the rays are short, and curves are present, this form is called a *rayed band;* if the rays are long, and the folds move as if swayed by a breeze, we speak of a *drapery*. When the rays approach the magnetic zenith, they converge and may form a crown or *corona*.

The term *ray* (*R*) is applied to isolated individual rays or to narrow bundles of rays. They look much like searchlight beams, varying in width from a few minutes of arc to a few degrees, and are from 2 to 60 degrees long, with sharply defined nearly vertical edges. Rays apparently converge at a point about 20 degrees south of the zenith, an effect of perspective. Observations of rays are important, as this form is unusually high above the earth's surface, sometimes even 650 miles.

Especially striking are the pulsating features. A *pulsating arc* (*PA*) consists of a homogeneous arc, or part of one, that brightens and fades rhythmically, in a cycle lasting from a few seconds to a few minutes. *Pulsating spots* (*PS*) are diffuse patches, not parts of arcs, that undergo brightness variations of this kind.

Finally, the *flaming aurora* (*F*) consists of quick-moving waves of light rising toward the zenith, or of invisible waves that cause parts of arcs, bands, and patches to appear and disappear rhythmically, but always with an apparent upward motion. This form often appears near the climax of a strong display.

**The Sequence of a Display.** Usually the occurrence of these forms during a display follows a well-marked sequence. The start is characterized by glows and homogeneous arcs, forms that have little motion. Later, rayed forms with considerable motion predominate—rayed arcs, rays, and sometimes flaming auroras. This stage is often accompanied by increased brightness, and the appearance of distinct colors. Then, in the declining phase, indistinct patches of aurora are the most conspicuous features. These may include glows, patchy auroras, pulsating forms, and sometimes diffuse rays. However, the entire sequence may not occur in any one display.

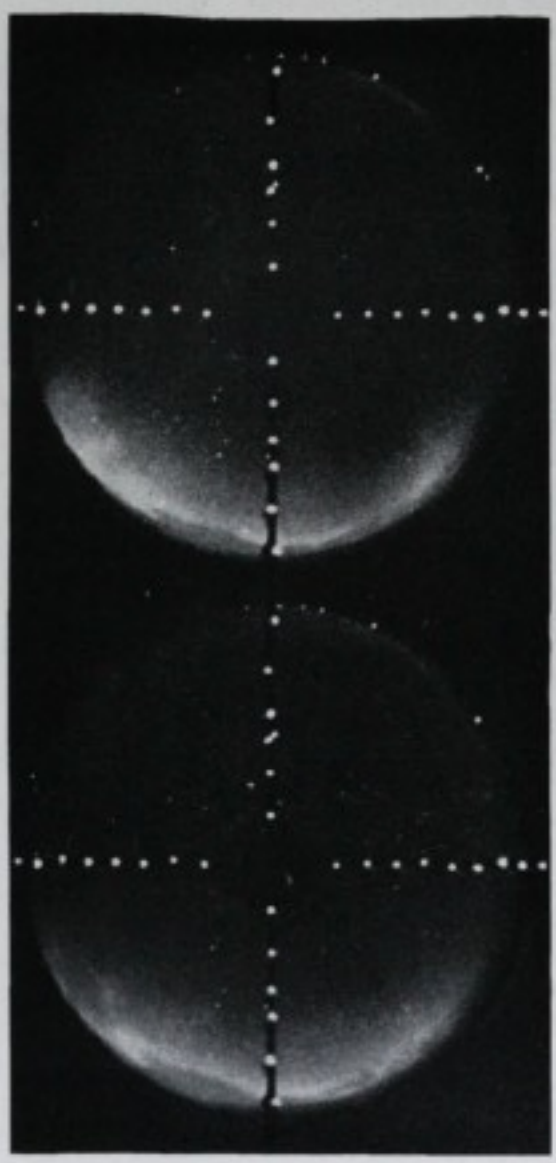


**Fig. 4. At Cornell University, where Dr. Gartlein has studied the aurora for many years, photographs of the northern lights are made with an all-sky camera that gives a minute-to-minute record of the heavens. On February 24, 1957, there was a ragged band along the northern horizon (lower edge of each frame) with a glow above it. The change that occurred in one minute is shown by these pictures, taken at 1:44 and 1:45 a.m. Eastern standard time. The tiny spots along the quadrant lines are markers to indicate angular elevation. Cornell University photographs.**

**The Report Form.** In the North American program, volunteer observers will make periodic inspections of the sky, as nearly as possible on each quarter hour by the clock. Each auroral observation is recorded on a 4-by-6-inch printed card. The hemispherical visible sky is represented in four quadrants, on which lines of 30° and 60° altitude are printed. On this card the observer can show the approximate directions and altitudes of the auroral features. Each form is sketched (as shown in Fig. 1) and marked with its proper abbreviation, and if there is any motion, the direction is indicated by an arrow.

The observer notes also the brightness and the color (if unusual) of each auroral form. The standard intensity scale is: *weak* (*w*), matching the brightness of the Milky Way; *medium* (*m*), like moonlit cirrus cloud; *bright* (*b*), like cumulus cloud in moonlight; and *very bright* (*v*). Often the surface brightness of the aurora is so low that the usual yellowish-green color is not apparent. About five per cent of the time, red, blue, or violet-grey hues are seen; these rarer colors should be noted when they occur.

The large amount of detailed information that can be furnished by such a graphic report card is illustrated in Fig. 3. This is a fictitious observation at Ithaca, N. Y., on the night of April 6-7, 1957, at 9:15 p.m. Eastern standard time. In the southern sky there was no aurora, as indicated by the symbol 0. A homogeneous arc of medium brightness extended from the western horizon into the north, crossing the meridian at an altitude of

80° above the northern horizon, but its eastern end was hidden by clouds stretching nearly 30° up the sky. Also in the north was a bright, rayed band at an altitude of 50°, which had a red lower border and was moving eastward. About 30° west of north there was a narrow group of medium-intensity rays, extending in altitude from 8° to 20°. Check marks at the bottom of the card indicate that the elevations were measured and not estimated, and that there is additional data on the other side of the card.

This graphic system of auroral reporting is one of the most useful innovations in visual work during recent years; it allows the convenient analysis of great numbers of observations that would be far more laborious to handle if they were in verbal form.

In addition to recording the auroral forms and their light intensities, observers are requested to note the times at which certain sudden changes occur. These events, it is believed, are associated with changes in the earth's magnetic field, earth currents, and the ionosphere. When does a new form first become visible? When does one form change into another? If a pulsating or flaming aurora is present, it is valuable to watch it continuously, and record the times of its successive appearances and disappearances.

**Altitude Measurements.** If a given auroral feature is exactly overhead, the fact is of considerable importance. To find your *zenith* by eye alone, first estimate the overhead point while facing north, then while facing south, and take the average position between the two estimates. In this way observers can readily locate the zenith to within five degrees.

The value of an auroral report is greatly increased if actual measurements of the altitudes of features above the horizon are included. While many devices can be used for measuring angular elevation, a simple inclinometer that is light enough to be held in the hand will give an accuracy of one degree. As may be seen in Fig. 5, it consists essentially of a protractor and a plumb bob. Such a protractor is printed on the back of the standard report form, which is fitted in the device against a projecting strip so that the center of the circle is at the pivot of the string. The card is clamped in this position, and, with the string hanging free, the observer tilts the inclinometer until he can sight along its edge to the auroral feature. When the lining up is satisfactory, he pinches the string to the card, and either reads off the angle or else records the position of the string by a pencil mark.

In altitude measurements of an arc or band, sight on its *lower* border. For glows and isolated rays, the altitudes of both top and bottom are taken.

**Fig. 5. Sharon Molloy, of Hillhouse High School, New Haven, Connecticut, demonstrates the use of the inclinometer and reporting card for measuring the altitudes of auroral features above the horizon of the observer.**

In the North American program of visual auroral work, most measurements will be carried out with such inclinometers. Certain stations, however, where relays of observers can regularly carry out all-night observations, will be provided with alidades for more precise measurements. These instruments are mounted on posts so that altitudes are measured only in a north-south plane. Each pointing of the alidade on an auroral feature is recorded by a pencil mark on a special card.

**Filters.** Every visual observer of the aurora is often faced with the problem of deciding whether a faint luminosity in the sky is actually an aurora or merely moonlight or scattered city light. This decision is greatly facilitated by a simple filter device to be used in the North American IGY auroral program (Fig. 6). It consists of three small cellulose-acetate Wratten filters—red (25), blue (47), and green (57 and 21)—bound in glass.

By looking through such a device, the observer can compare directly the brightness of the sky in these three colors. If an aurora is present, the green filter looks lightest, or occasionally the red one. Moonlit clouds will generally appear brighter in blue than green, with the red quite dark. Sky glow from city lights, if faint, is about equally bright in blue and green, with red darker. If, however, the city lights are fairly bright, the three colors will look more nearly equal.

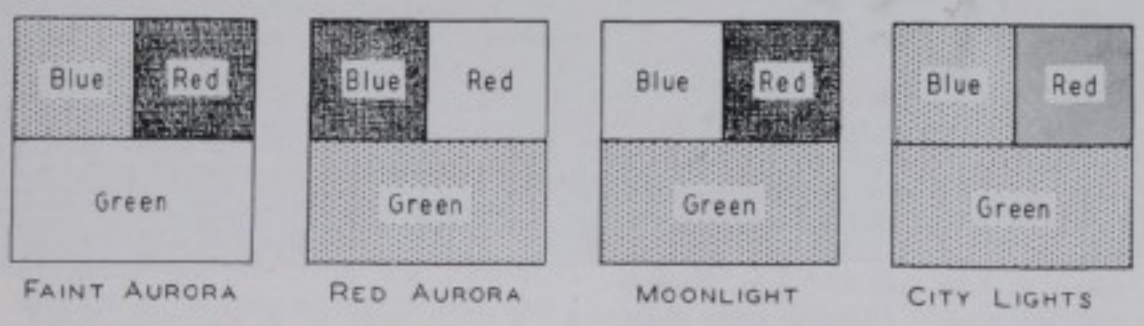



**Fig. 6. A convenient way to distinguish between actual auroras and other kinds of sky illumination is by inspection through color filters, giving the distinctive appearances shown here.**

**When to Observe.** During the International Geophysical Year, which runs from July 1, 1957, to January 1, 1959, solar activity will be at a high level (one reason that this period was selected) and displays of the northern lights will be comparatively frequent. While auroras generally tend to occur more often in March and April, as well as in August and September, the volunteer observer in the IGY program cannot work only in those months.

In Canada and the northern United States, observations should be made every clear night, if possible. Southern observers, in latitudes below about 40°, should concentrate on those nights when geomagnetic disturbances, and hence auroras, are to be expected. Such favorable times will be predicted by the IGY World Warning Agency on the basis of the sun's activity, and alerts will be called. When a great disturbance is imminent, special world intervals (SWI) will be declared.

It is hoped that the alerts can be announced by standard-band radio stations, but plans are not definite except for announcements by short wave. Station WWV will broadcast the warnings on frequencies of 2½, 5, 10, and 15 megacycles in Morse code twice hourly, at 19 and 49 minutes after the hour, just after the radio propagation announcement. The code will be:

AGI—AAAAA State of alert
AGI—EEEEE No state of alert
AGI—SSSSS SWI will begin at 0:01 UT of the following day
AGI—Three extra long dashes SWI in progress
AGI—TTTTT SWI terminates at 23:59 UT of the same day

Local radio amateurs may be willing to

assist in monitoring these announcements. Telegraphic and radio disturbance, unusual flutter of radio signals, and moving bars on the television screen are usually closely associated with the aurora. If such disturbances are noted in the late afternoon, they probably indicate an aurora will be seen that night.

Observations should begin near the end of twilight, and be made as nearly as possible on the even quarter hours. However, the exact time of observation should be recorded to the nearest minute. When several observers are available at the same location, they should take turns so observations can be carried into the morning hours and the decline of a display carefully observed.

Persons who cannot follow the 15-minute schedule should make individual observations whenever possible, especially after midnight. Every volunteer should send in at least a qualitative report whenever he sees an aurora.

**Instructions.** Astronomical societies and individual amateurs in the United States planning to participate in this program can receive detailed instructions and supplies of report forms, free of charge, by writing to Dr. C. W. Gartlein, IGY Auroral Data Center, Rockefeller Hall, Cornell University, Ithaca, N. Y. Canadian observers should communicate with Dr. Peter M. Millman, IGY Auroral Centre, National Research Council, Ottawa, Ontario, Canada.

Many other countries participating in the IGY have established headquarters for auroral work. For instance, in Great Britain it is at the department of natural philosophy of Edinburgh University, in France at the Institut d'Astrophysique of Paris, and in Japan at the Tokyo Astronomical Observatory.

### THIS MONTH'S MEETINGS

**Cleveland, Ohio:** Cleveland Astronomical Society, 8 p.m., Warner and Swasey Observatory. May 10, annual dinner, Dr. Donald A. MacRae, David Dunlap Observatory, "The Goings and Comings of Stars."

**Dayton, Ohio:** Miami Valley Astronomical Society, 8 p.m., Museum of Natural History. May 10, motion picture, "Our Mr. Sun."

**Madison, Wisc.:** Madison Astronomical Society, 8 p.m., Washburn Observatory. May 8, Kenneth L. Hallam, Washburn Observatory, "Astronomy in the Pacific."

**New York, N. Y.:** Amateur Astronomers Association, 8 p.m., Museum of Natural History. May 15, annual business meeting. Also May 18, 6:30 p.m., Stouffer's restaurant, 30th anniversary dinner.

**Washington, D. C.:** National Capital Astronomers, 8:15 p.m., Commerce Department auditorium. May 4, John H. DeWitt, Station WSM, Nashville, Tenn., "A Seeing Compensator Employing Television Techniques."

# *Amateur Astronomers*

### STELLAFANE MEETING

The 1957 Stellafane meeting will be held on August 3rd at Breezy Hill, Springfield, Vermont, one day after the first quarter moon. The Springfield Telescope Makers and the Amateur Telescope Makers of Boston are once again cosponsors of the event.

Speakers of last year's meeting have been invited to return with latest information on the satellite program and the amateur's role in this national scientific venture. The afternoon will be devoted primarily to discussions by a panel of specialists on questions from the audience.

In judging telescopes and their performance, recognition will be given to all classes of instruments, advanced designs being judged in a special class.

Room reservations can be made through Mr. Merryfield of the Hartness House, Springfield, Vt. More information about the meeting is available from James W. Gagan, ATM's of Boston, Harvard College Observatory, Cambridge 38, Mass.

### H. A. WALLACE DIES

A very active promoter of West Coast amateur astronomy, H. A. Wallace, passed away at the age of 77, on March 6th in San Francisco. He was instrumental in organizing the Western Amateur Astronomers, and had served on its board of representatives since its inception. By profession Mr. Wallace was a railroad signal engineer whose inventions in this field revolutionized earlier methods.

He enthusiastically gave much of his time to fostering astronomy in the San Francisco Bay area. His shop was used by telescope makers, and dozens of telescopes were completed there. Founder of the San Francisco Amateur Astronomers, he was also a member of three other clubs—the Eastbay Astronomical Society of Oakland, the Peninsula Astronomical Society of Palo Alto, and the Marin Amateur Astronomers of San Rafael.

### ASTRONOMICAL ACTIVITY IN NEW YORK CITY COLLEGES

At the College of the City of New York an astronomical society has been formed by students under the guidance of Prof. Robert I. Wolff. The setting up of an optical shop and the installation of a small Schmidt telescope are planned, according to amateur astronomer Stephen P. Maran.

Following several dormant years, the observatory at Brooklyn College has been reactivated and a program of variable star observing undertaken. Courses in astronomy are once more being offered. The instruments at the observatory include a 7-inch Fecker refractor and a transit instrument of 3-inch aperture. Construction of a small radio telescope is under consideration.

The MOONWATCH team of the Amateur Astronomers Association's observing group has applied for permission to set up a satellite observing station at the Brooklyn College's Roosevelt Field.

### STUDIO CITY, CALIFORNIA

Correspondence from junior groups would be welcomed by the Tycho Astronomical Society, which recently celebrated its first anniversary. Club president is Bob Flaig, 4000 Coldwater Canyon, Studio City, Calif. The club has a 4-inch reflector, which is currently being used for planetary observing.

### GALESBURG, ILLINOIS

At a recent Galesburg Amateur Astronomers meeting, Dr. Herbert Priestley, head of the Knox College physics department, gave a talk on the International Geophysical Year and the artificial satellite program.

Now in its fourth year of activity, the club schedules two meetings monthly, one of which is an observing party. Besides owning several telescopes, the 25 members, half of whom are juniors, have access to the 6-inch Clark refractor of Knox Observatory. The society is a member of the Astronomical League.

RICHARD B. FRITZ
517 S. West St.
Galesburg, Ill.

### NORTH CENTRAL CONVENTION

The North Central Region of the Astronomical League will hold its 11th annual convention on Saturday, May 11th, at Macalester College, St. Paul, Minn. The St. Paul Telescope Club will be the host society.

Dr. C. M. Huffer, of Washburn Observatory, will talk on "The Literature of Astronomy." Carl H. Gamble, of Moline, Ill., will speak on his experiences as an amateur astronomer. Further information may be secured from H. B. Porterfield, 1001 University Bay Drive, Madison 5, Wisc.

### WEST PALM BEACH, FLORIDA

The Astronomy Club of the Palm Beaches was organized in November, 1955, with 19 charter members, the outgrowth of an astronomy class given by the county adult education department. The instructor, Dana Hawkins, was named permanent honorary president. Monthly meetings are devoted to lectures, round-table discussions, or observing through telescopes. Further information may be had from Mrs. William A. Bound, Jr., 808 Cypress Drive, Lake Park, Fla.

# NEWS NOTES

### *PHOTOMETRY OF MARS*

Photoelectric measurements of the brightness of Mars during 1952 are reported by Audouin Dollfus, Pic du Midi Observatory, in the January 7th issue of the *Comptes Rendus* of the Paris Academy of Sciences. He has found that the magnitude of Mars at mean opposition is −1.88, from 22 observations in yellow light that are nearly on a visual scale. Hence the average albedo or light-reflecting power of the planet's surface is 0.235.

The same observations show that the variation of Martian brightness, as rotation brings lighter or darker features onto the disk, is 0.4 magnitude. Mars was brightest when the great ocher deserts near longitudes 45° and 135° were central on the disk, and faintest when Syrtis Major was on the visible side of the planet.

From the brightness of the desert regions at different distances from the center of the disk, Dr. Dollfus concludes that they are perhaps covered with powdery substances. The desert surface material scatters light much as do the terrestrial minerals göthite and limonite, which may indicate that the desert material is also hydrated oxides of iron.

### *GLACIERS AND SUNSPOTS*

That glaciers may have higher growth rates when sunspots are least numerous was discussed by Dr. Donald B. Lawrence, professor of botany at the University of Minnesota, in his Sigma Xi lecture, "Glaciers and Vegetation in Southeastern Alaska," given recently at 30 places in the northeastern United States and Canada.

The Eliot glacier on Mt. Hood, Oregon, appears to have reached its greatest advance about the year 1740, according to growth layers of a tree pushed over partway by the ice pressure. The Mendenhall glacier, 12 miles north of Juneau, Alaska, has receded two miles since about 1765. Nine other glaciers also had their maximum positions in the early or middle 18th century, and radiocarbon dating shows that trees overridden by the latest advance of North American glaciers were alive less than 500 years ago. In southwestern Norway, the Nigardsbre glacier grew larger in the late 17th century but its recession began in 1748.

Dr. Lawrence associates these changes with the dearth of sunspots from 1645 to 1715; it was for this time also that tree-ring patterns failed to reflect the 11-year sunspot cycle. A study of a score of ridges formed during the recession of the Herbert glacier north of Juneau reveals a tendency for moraine formation (reflecting favorable glacier nutrition) to occur at the time of minimum sunspot activity in each cycle.

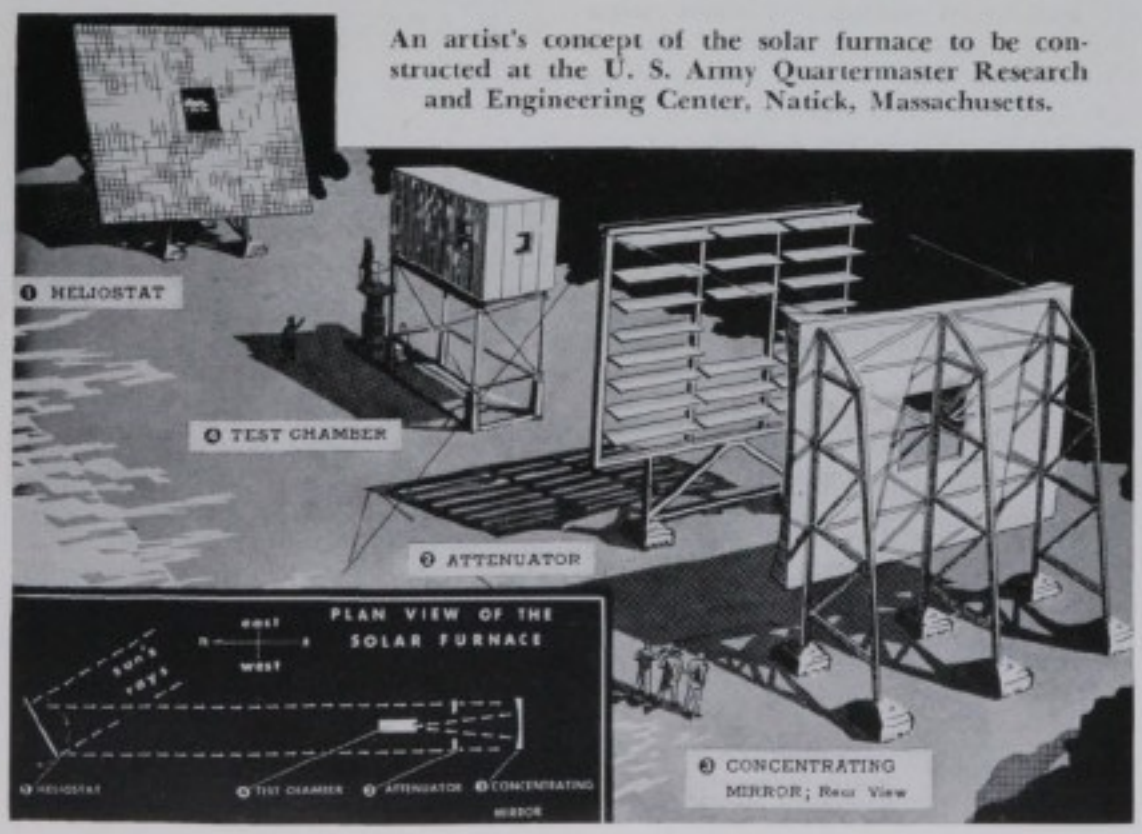
### *ARMY SOLAR FURNACE*

A giant solar furnace is to be erected at the U. S. Army Quartermaster Research and Engineering Center, in Natick, Massachusetts. The furnace will have an energy equivalent of about 28,000 watts, and will be used to test materials intended for the protection of military personnel against the thermal effects of nuclear and other weapons.

Standard sources of intense heat, such as electric arcs, gas-fired panels, and burning magnesium, are not adequate because they are not hot enough, do not uniformly cover a large area, and are not easily controlled. Within the test chamber of this furnace the sun's rays will be collimated in an intensely hot beam four inches in diameter.

The installation has four principal elements, as shown in the sketch. At one end is the heliostat, a flat mirror 40 by 36 feet, driven to follow the sun across the sky. It will reflect the sun's rays a distance of 96 feet upon the concentrating mirror array, which has a paraboloidal cross section and will be made of 180 mirrors, each 23.5 inches in diameter. Before reaching the target or test chamber, the rays will pass through the attenuator, an enormous Venetian blind shutter which can reduce the intensity of the light as desired.

The Quartermaster Corps is designing the optical components, while the mechanical framework, foundations, and drive mechanism are being made by D. S. Kennedy and Co., who erected the 60-foot radio telescope of Harvard Observatory.




**An artist's concept of the solar furnace to be constructed at the U. S. Army Quartermaster Research and Engineering Center, Natick, Massachusetts.**

### *SOLAR POWER STATION IN THE CAUCASUS*

A full-scale solar power station to serve industry is to be built in Armenia, near Lake Aigerlich on the Ararat Plain. To protect the collecting mirrors from dust, the installation is surrounded by trees that form a ring nearly one kilometer in diameter.

Inside this ring will be 23 concentric circular railroad tracks, carrying trains of cars on which 1,293 mirrors are to be mounted. The mirrors will direct solar radiation to a boiler at the top of a 130-foot central tower, where steam will be

### IN THE CURRENT JOURNALS

THE DEVELOPMENT OF RADIO ASTRONOMY, by Gerald S. Hawkins, *American Scientist*, January, 1957. "The output of the natural transmitters of the cosmos is far greater than any we can make on the earth. Cygnus A for example, on the edge of the visible universe, puts out a power which is more than a billion billion times greater than our man-made signals."

THE CRAB NEBULA, by Jan H. Oort, *Scientific American*, March, 1957. "The Crab Nebula . . . provides a unique opportunity to see what becomes of a star after a great explosion. What is more, it has presented, upon inspection with modern instruments, a strange and totally unexpected physical phenomenon which is now exciting keen interest. . . ."

AN INTERNATIONAL OBSERVATORY, by John B. Irwin, *Scientific Monthly*, March, 1957. "It would seem to be high time to start planning for a new international observatory, an observatory operated by American astronomers but located either in South Africa, South America, or Australia, an observatory that would take full advantage of the most unusual observing opportunities to be found in the southern skies."

generated at a pressure of 30 atmospheres. From here the steam is to be piped to a turbine that will have a capacity of 1,200 kilowatts.

Plans call for largely automatic operation of the station. Photoelectric control devices will keep the cars positioned so the mirrors always point sunward and the boiler turned to keep its flat side toward the reflected beams.

The Ararat Plain location is unusually advantageous, for it enjoys an average of 2,600 hours of sunshine per year. The main use of the electric power generated by this station will be to drive pumps for irrigation and for draining swampland.

### *OKLAHOMA METEORITES*

Since 1951, four meteorites have been recognized from three counties in central Oklahoma that lie north and south of each other: Kingfisher, Grady, and Stephens. In discussing the latest find, the Amber, Oklahoma, aerolite, Dr. Frederick C. Leonard, University of California at Los Angeles, asks whether or not three of these might not belong to one far-flung shower of which additional members await discovery.

In the December, 1956, *Publications* of the Astronomical Society of the Pacific, Dr. Leonard publishes a picture of the Amber meteorite that was sent to him by Van Long, of Chickasha, Oklahoma. In plowing his property at a point three miles south of Amber, Mr. Long had found this meteorite in 1934, but plowed it under as he then thought it was merely an ordinary rock. On second thought, he decided it might be a meteorite, but he could not find it again for 21 years.

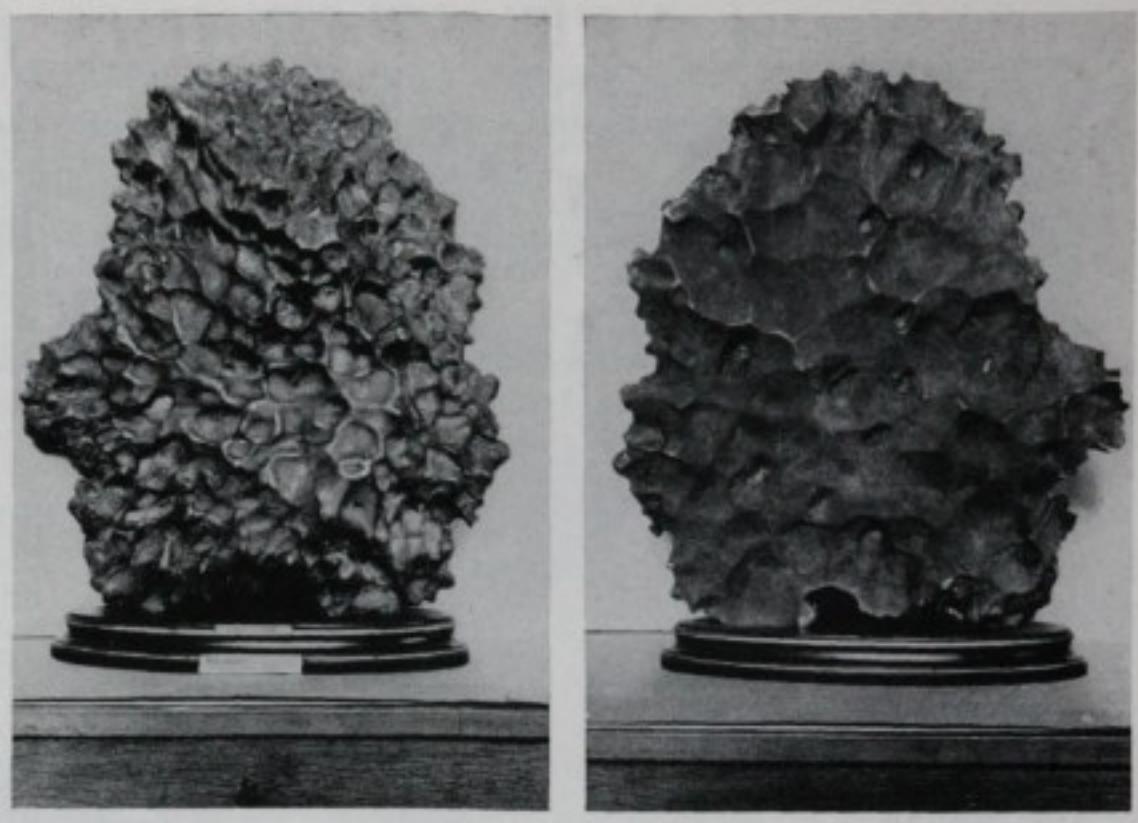
From fragments sent to Dr. Leonard, the meteorite is provisionally classified as a black, crystalline, spherulitic chondrite, with liberal inclusions of nickel-iron. Its total weight is 4.532 kilograms, and it appears to be roughly spheroidal, about seven inches in diameter.

In Cashion, Kingfisher County, a similar meteorite was found in 1936 and recognized in 1954; at Kingfisher, another was picked up in 1950 and recognized in 1951. At Marlow, Stephens County, a meteorite of another type was found in 1936 and recognized in 1954. Dr. Leonard points out that 18 meteoritic falls are now on record for the state of Oklahoma.

### *NEW METEOR SHOWER*

An unexpected rich shower of meteors was observed from several places in South Africa on the evening of December 5, 1956, according to *Circular* 382 of the British Astronomical Association. Between 20 and 100 meteors per hour were counted by different observers near the time of peak activity. Many of the meteors were very bright.

From 40 meteor tracks plotted by S. C. Venter, the radiant point of the new shower has been determined as right ascension $1^h\ 00^m$, declination $-45°$. As this position is near the star Beta Phoenicis, the shower has been named the Phoenicids. There is some similarity between the orbital elements of this stream and those of Comet 1819 IV, but a physical connection between them is uncertain.



**Among the meteorites examined by Dr. John S. Rinehart in his study of ablation is this 107-pound iron found at Cabin Creek, Arkansas. Many large holes, about three inches in diameter and two inches deep, have been scoured out of the front face (left-hand view) and are uniformly distributed over the surface. The pits are slightly elongated, with their long axes pointing toward the nose of the meteorite. The rear surface (seen at right) is relatively free of these holes. Photograph reproduced by courtesy of E. P. Henderson.**

### *ABLATION OF METEORITES*

During the rapid fall of a meteoritic body through the earth's atmosphere, a marked ablation or wastage of its surface material occurs. Most meteorites enter the air at speeds of about 10 miles a second, whence they are subject to considerable aerodynamic heating and wearing away of their forward parts.

At the Smithsonian Astrophysical Observatory, Dr. John S. Rinehart has examined the shapes and surface features of more than 70 meteorites. He finds that the ablation is usually roughly symmetrical about an axis parallel to the path of the meteorite, and that in extreme cases an object may lose as much as half of its mass. But even though suffering severe loss, many meteorites maintain their orientation as they hurtle earthward.

The pattern of removal depends on the size and material of the body. Small meteorites, up to three inches in diameter, are smoothly sculptured. Large, stony meteorites show shallow, elongated depressions, while large irons have very deep pits gouged in them during flight.

**This small chunky iron meteorite, which fell in Bruno, Saskatchewan, weighs about 25 pounds and is roughly eight inches in diameter. Little filaments of previously molten metal that cover the depressions indicate the flow of material along these surfaces, and strong curvature of the filaments in certain areas suggests intense air eddies. The front of the meteorite in flight is toward the upper left. American Meteorite Museum photograph.**

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# BULLETIN FOR Visual Observers of Satellites

NUMBER 6 — 60 GARDEN STREET, CAMBRIDGE 38, MASS. — MAY, 1957

## National Committee Meeting

Members of the National Advisory Committee met with the optical tracking program staff at the Smithsonian Astrophysical Observatory in Cambridge, Mass., on February 1st and 2nd to review various phases of the MOONWATCH project. The lively discussions centered on the techniques of visual observing, both committee and staff agreeing that further explanation of the observing methods should be presented in the *Bulletin*. An article on that subject, arising in part from this exchange of views, is included in this issue.

Members of the committee attending were: G. R. Wright, Thomas A. Cragg, Walter H. Haas, Edward A. Halbach, Arthur S. Leonard, Charles H. LeRoy, Russell C. Maag, Walter Marion, Mrs. Margaret W. Mayall, Miss Grace C. Scholz, Steadman Thompson, and Bradford A. Smith, the latter representing Clyde Tombaugh, who was unable to come.

Attending as guests were Col. Owen F. Clarke, liaison with the U. S. Air Force for MOONWATCH, and Paul H. Oehser of the publications office of Smithsonian Institution, Washington. Colonel Clarke summarized the Air Force's plans for providing flybys for MOONWATCH-station simulated observing sessions, and Mr. Oehser discussed public relations aspects of the visual observing program.

Committee members and guests were welcomed to the observatory by Dr. Fred L. Whipple, director, and Dr. J. Allen Hynek, associate director of the observatory and in charge of the satellite tracking program. Dr. Hynek presided at the sessions, being relieved at times by Dr. Armand N. Spitz, coordinator of visual observations, and by Leon Campbell, Jr., supervisor of station operations.

## South American Stations

MOONWATCH has spread to South America, where about a dozen teams are being organized. This new development has been stimulated by the work of Dr. Hynek and Teofilo Tabanera, of Buenos Aires, Argentina, who together recently visited several of the groups who will participate. Sr. Tabanera has also been translating these bulletins into Spanish and circulating them among interested groups in Latin America.

In the eastern part of South America, Dr. Hynek and Sr. Tabanera laid the groundwork for teams in Buenos Aires and in Montevideo, Uruguay. Carlos L. Segers, with whom Sr. Tabanera has worked closely, is the prospective leader of the Buenos Aires group.

There is also activity in Chile, on the west coast of the continent. In Santiago, Drs. Erich P. Heilmaier and Federico Rutllant are getting satellite observers together, and to the north, in Antofagasta, German E. Saa, S. J., heads a team of students at the College of San Luis. This group will set up its station on the

*The National Advisory Committee meeting on February 1-2 in the Phillips library of Harvard College Observatory. Seated from left to right are: LeRoy, Cragg, Halbach, Leonard, Thompson, Oehser, Hynek, Miss Scholz, Campbell, Spitz, Wright, Maag, Haas, Smith, Clarke, Marion, and Mrs. Mayall. Photograph by Robert E. Cox.*

college basketball court, which happens to be laid out so the meridian is along the diagonal of the court—a most fortunate circumstance for MOONWATCH observing. Father Saa's team may lay claim to being the first in South America to acquire a sponsor, for on the same day that he decided to form it, the Chilean Exploration Co. (Anaconda Copper) came forward and agreed to underwrite the station.

### Correction to Bulletin No. 5

On page 3 of *Bulletin* No. 5, February, 1957, the second sentence in the note by Dr. Hynek should read as follows (changing *minute* to *degree*):

"The *Bulletin for Visual Observers of Satellites* will continue to present alternative methods for accomplishing the primary objective: to determine the position of the satellite within a degree of arc, and when it occupied that position to a second of time."

*Left: This mountain in Antofagasta, Chile, is the proposed site of a MOONWATCH station. In the foreground is the roof garden of the Carrera Hotel.*

*Right: While on his recent tour in South America organizing satellite visual observing teams, Teofilo Tabanera was photographed on the Buenos Aires-Montevideo night boat.*

## XII. Observing Methods for MOONWATCH

*A. The Essential Data.* In all problems of orbit calculation and analysis, the computing center will use the right ascension and declination of the satellite in the sky, and the time it occupied that position. These are the essential data of a successful MOONWATCH observation.

For the purposes of the computer, any one of several observing techniques might be used, and the satellite could be observed in almost any part of the sky. The result should be reported to the computing center in whichever of the several systems of co-ordinates seems most convenient. The basic requirement is that the position be given to an accuracy of one degree of arc and the time to one second.

There are, however, certain practical advantages in narrowing our choice of methods. For instance, the desirability of establishing a meridional fence as the basis of any MOONWATCH observing routine is well established. Since the satellite's motion will be predominantly from west to east, when it does pass within range of a station it will almost certainly have to cross the meridian. It will, in fact, always reach its greatest height above the horizon and be in the best position for observation not far from the meridian. In the absence of more specific information about the satellite's orbit, the meridian is obviously the most profitable part of the sky to watch.

The time and position reported to the computing center, then, will always be determined at or near meridian passage. Next, how can the observations best be made?

*B. Two Observing Techniques.* Two basic methods are used by astronomers to determine the position of a celestial body, one fundamental, the other differential.

The fundamental method involves direct measurement by means of instruments such as a meridian circle. For example, as a bright star crosses the meridian, its declination can be found by measuring its altitude, while its right ascension is equal to the sidereal time of the meridian passage.

The differential method involves the measurement of differences in position, either on a photographic plate or with a telescope micrometer, between the object whose position is desired and nearby stars whose places are already known. Such techniques are used at observatories to find the positions of comets and asteroids, and they will be used to determine the position of the satellite in the precision photographic tracking program.

Either of these two basic methods of the astronomer can be adapted to the needs of MOONWATCH. The first method can be used if a marker is provided, either a mast or a reticle, that accurately defines the meridian in the field of the observer's telescope. All the observer must do is give the time signal and note the satellite's position, as it blinks out behind the marker, in fractions of the field above or below the center.

Since the angular size of the field and the position of the telescope on the meridian will be known, the meridian altitude can be computed easily as soon as the satellite has left the field. It will be necessary to

state whether the satellite passage was north or south of the zenith. The computing center, knowing the latitude and longitude of the station, can readily convert the meridian altitude of the observation into declination and the time into right ascension—the data that will be used in the electronic computer.

The second method, in its simplest form, makes use of star charts alone, without the aid of a meridian marker. The stars provide a background against which the position of the satellite can be determined at any moment during its passage across the field of the telescope. The accuracy of the observation may be considerably increased if the position is timed when the satellite passes close to a bright star or a prominent group of stars.

Therefore, it will be perfectly acceptable if a team of experienced observers decides to adopt the second method and eliminates the meridian marker entirely. This will obviate the work of erecting a mast or of inserting reticles in telescopes. The telescope field is unobstructed, with a consequent reduction in observer fatigue—as Dr. G. Van Biesbroeck points out, the observer may then work much like the driver of an automobile who does not stare tensely straight ahead but maintains a relaxed watch over the entire area of his vision.

*C. The Recommended Technique.* If the telescopes and the meridian marker have been carefully aligned, the first method will provide all the data that is necessary. However, it is strongly recommended that, whenever possible, the satellite's position be obtained also with reference to the star field. In this combination of methods, the observer can mentally "photograph" the satellite path against the background of stars. As in the fundamental method, he will give the time signal when the satellite passes behind the meridian marker, but as soon as the satellite leaves the field the observer will record its path on a star chart. Furthermore, the position of the meridian marker can be placed on the star chart, and the position of the satellite's meridian passage read directly from the chart in terms of right ascension and declination.

This combination technique is recommended over the fundamental method alone chiefly because it provides a graphic record of the observation and gives assurance that the required accuracy in position will be obtained. And from the amateur astronomers' viewpoint, it introduces more real astronomy into the work, thus making MOONWATCH observing more interesting and enjoyable.

However, it should be emphasized that if the observer fails to note the path of the satellite with respect to the stars the observation is not invalidated. The time and altitude of meridian passage with reference to an accurately aligned marker will be sufficient for the computer.

The recommended MOONWATCH technique can be summarized:

1. A marker is provided to define the meridian accurately in the field of each telescope.

2. The time signal is given when the satellite passes behind the marker.

3. The position along the marker where the satellite crosses it is estimated, as a fraction of the field diameter above or below the center.

4. When possible, the path of the satellite with respect to the stars is noted and, after the satellite has left the field, the path is plotted on a star chart.

5. The meridian altitude is computed from the position of disappearance behind the marker and from the declination of the center of the telescope field of view. If the path has been plotted, the position of the marker is drawn on the star chart and the position of meridian passage in right ascension and declination is read from the chart as well.

6. Times and positions determined by both methods should be included in the report of the observation.

7. Other information is desirable: the position angle of the path of the satellite, its angular velocity, and apparent magnitude. But such information is not essential, and supplying it is at the discretion of each team.

*D. Alignment to the Meridian.* The National Advisory Committee has recommended the use of a mast as the most positive and reproducible means of aligning observers' telescopes on the celestial meridian. The layout of a station with a mast was described in *Bulletin* No. 2.

It was pointed out in *Bulletin* No. 5, however, that a vertical wire in the focal plane of the telescope would also serve as a satisfactory meridian marker. This device allows considerable freedom in the arrangement of the station's observers, and permits table-top mounting of the instruments. But it is much more difficult to provide and maintain accurate meridian alignment of the reticle-equipped telescopes.

The best way to adjust the reticle accurately in the meridian is by observation of stars. A particular star will be on the meridian when the local sidereal time equals the star's right ascension. The sidereal time can be found as the sum of four items. We shall take each of these to the nearest 0.1 minute of time, and round off their sum to the nearest minute. The items are:

1. The *sidereal time at 0h Universal time.* This is listed for each day of the year in the *American Ephemeris and Nautical Almanac.* For example, on August 4, 1957, this is $20^h\ 49^m.2$, as we see by consulting page 10 of the 1957 volume, last column.

2. Your *standard time,* as normally kept at your station. Express it from 0 to 24 hours; thus, 10:30 p.m. Central standard time should be written as 22:30 CST.

3. The *longtitude correction* amounts to four minutes of time for each degree between your station and the standard meridian of your time zone. Add this correction if the station is east of the standard meridian, subtract if it is west. Therefore, for a station at longitude 92°.1 west, the correction is −8.4 minutes.

4. The *difference between the solar and sidereal interval.* First, express your standard time as Universal time; thus, for the Central standard time zone, which

is six hours west of Greenwich, the Universal time of 22:30 CST is 28:30 (the next day). Next, divide the Universal time, expressed in hours, by six to get the correction in minutes. For 28:30, it is 28.5/6 or +4.8 minutes. This correction is always positive.

As an example, find the local sidereal time at 22:30 CST on August 4, 1957, for a station in longitude 92°.1 west:

| | |
|---|---|
| 1. Sidereal time at 0$^h$ UT ..... | 20:49.2 |
| 2. Standard time ..... | 22:30.0 |
| 3. Longitude correction ..... | −8.4 |
| 4. Solar-sidereal interval ..... | +4.8 |
| Sum ..... | 43:15.6 |

Subtract the superfluous 24 hours and round off the result to the nearest whole minute. The local sidereal time is therefore 19:16.

If the sidereal time is computed for a specific standard time just prior to aligning the telescope, the observer can set his watch to the proper sidereal time when that standard time occurs, and this will provide him with the approximate sidereal time for the rest of the evening.

When this has been done, it should not be difficult to line a telescope on the meridian. The instrument should be set on an accurately level surface, with the base of the mounting oriented beforehand nearly along a north-south line. The meridian marker should be as nearly vertical as possible, and the telescope should point toward the elevation at which it will be used for the satellite patrol.

Select a number of stars that are about to transit the meridian in the field of the telescope, and scale their right ascensions from a star chart. Wait until the sidereal time equals the right ascension of one of the stars and at once shift the telescope in azimuth until the star falls behind the marker. Repeat the process for stars at the top and bottom of the field because the reticle may not be exactly vertical—adjust it by turning the portion of the eyepiece that holds it.

## REGISTRATION OF MOONWATCH STATIONS

Twenty-nine teams have been added to the list of registered MOONWATCH stations since the first 40 were published in the February issue of the *Bulletin* (No. 5). As the Decatur, Ga., team has recently merged with the Hapeville, Ga., group, the total of registered stations is now 68. Groups in Hawaii and the Union of South Africa are the first registrants outside the continental United States.

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### ATOMS AND THE UNIVERSE

**G. O. Jones, J. Rotblat, and G. J. Whitrow.** Charles Scribner's Sons, New York, 1956. 254 pages. $4.50.

THE SUBTITLE of this new book by three University of London professors is "An account of modern views on the structure of matter and the universe," which sums up precisely the substance and style of the work. This outline of modern physics is by no means pedestrian, but is without the fancy icing that many authors use to decorate their popular books. It is a meat-and-potatoes production for those who want solid nourishment.

A large amount of material is included in a small space. There are five chapters on nuclear physics, one on the physics of solids and liquids—containing much new material that other popularizers of physics have not touched—and one chapter on relativity. Astronomy and astrophysics are covered in two chapters, and the final two are devoted to problems of cosmology. The unity of these subjects is stressed:

"The 'physical laws' which govern motions are constantly demonstrated and verified in elementary physics laboratories, but the important truth for us is that exactly the same laws govern the motions of the stars and planets. Thus physics and astronomy are part of a continuum; while astronomy deals with the motions of heavenly bodies, these motions are governed by physical laws which form one part of the province of physics. We would say that the part of this continuum of knowledge which is essentially physics concerns the fundamental nature of the laws relating to forces and motions; the part which is essentially astronomy concerns the detailed motions of the stars and planets. As physics and astronomy have developed, the continuity between them has been demonstrated in many other ways. Several examples of this continuity will be mentioned in this book."

The authors evidently feel that rigorous definitions may slow the reader; moreover, the general sense of most of the words in physics they use is well known. This policy has the disadvantage that occasionally the reader is brought up short by an undefined term or a group of words used in a special sense.

Only one major error was noticed. Page 161: "In practice, the solar parallax is obtained by considering the position of the sun relative to the background of the stars from two widely separated observatories on the Earth's surface. Knowing the base-line between these observatories and measuring the relevant angles, the solar parallax, and hence the sun's distance can be determined geometrically." The authors then go on to describe Sir Harold Spencer Jones' determination of the parallax from the Eros observations of 1931. This does not at all excuse the fact that the quoted method of determining the solar parallax is quite impractical, and merely an illustration of a principle.

The book has an index and a two-page bibliography, which is a well-chosen list of suggestions for further reading. The few diagrams are distinctive, uncluttered, and well labeled. Many of the 31 striking plates will be familiar to regular *Sky and Telescope* readers.

*Atoms and the Universe* is a well-integrated up-to-date review and can be conscientiously recommended to the serious reader.

STEADMAN THOMPSON
Columbus Astronomical Society

### BACK ISSUES

In answer to many inquiries concerning past issues of *Sky and Telescope*, Volumes I to IV are completely out of print. The following is a list of numbers available from our circulation department at 50 cents per issue (the volume year begins with the November issue):

Volume V (1945-46), Nos. 8 through 12 (June-October); Volume VI (1946-47), all but No. 6 (April); Volume VII (1947-48), Nos. 2, 6, 8, 9, 10, and 12; Volume VIII (1948-49), all but Nos. 3, 4, and 5; Volume IX (1949-50), all; Volume X (1950-51), all; Volume XI (1951-52), Nos. 2, 5, 7, 8, 9, 10, and 11; Volume XII (1952-53), Nos. 2 through 10; Volume XIII (1953-54), Nos. 6 through 12; Volume XIV (1954-55), all; Volume XV (1955-56), Nos. 2, and 5 through 11. All issues of the current volume are available.

Back issues, including some rare numbers, may also be obtained from the Midtown Magazine and Book Shop, 1105 Avenue of the Americas, New York 36, N. Y.

### GEOMETRICAL OPTICS

**L. C. Martin.** Philosophical Library, Inc., New York, 1956. 215 pages. $7.50.

AS EXPLAINED in the author's preface, this book is designed to serve as a brief course in geometrical optics for physics majors in college, and is therefore to be considered a substitute for the one or possibly two chapters on this subject usually found in texts on general physics. Considered in this light, it is an admirable volume, one that is likely to achieve the high stature that Dr. Martin's previous volume, *Technical Optics*, enjoys in its larger domain.

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approach and emphasis of a first textbook will long color our understanding. Therefore, such a book should say the right things in the right way and, equally important, in the right order.

In geometrical optics, for example, it is usually many years before a worker ceases to consider the aberrations of an optical system in the order in which he was first introduced to them. Dr. Martin's new book has departed from the conventional sequence of topics, following instead an order more suited to understanding their essential interrelationships.

An example of this fresh approach is found in introducing the ideal image-forming surfaces—ellipse, hyperbola, and Cartesian oval—before discussing the properties of the sphere. Again, the concept of sagittal rays is brought in at a very early stage. Postponement of any consideration of chromatic effects until relatively late in the volume is a logical arrangement not found, to the reviewer's knowledge, anywhere else.

The rather complete treatment of secondary chromatic aberration is new for books of this scope, and will be of considerable interest to many readers of this magazine. Such topics are seldom included in introductory texts. Other examples are the discussion of image formation in terms of the refractive powers of surfaces, and development of the paraxial theory of optical systems from the geometrical concept of collinear correspondence.

The student using this book is assumed to have had one or two years of college mathematics, so he can understand a number of significant proofs. By this use of mathematics, the author has been able to save space and to add rigor to his presentation.

In a few small points the book violates the reviewer's personal prejudices. I have a deep-rooted feeling against describing the action of plane mirrors and reflecting prisms in terms of the separate concepts of inversion and reversion, feeling that this subject is treated more generally and rigorously in terms of "handedness" and rotation. Furthermore, Dr. Martin's coverage of plane mirrors is extremely brief, and seems more likely to raise questions in the student's mind than to enlighten him.

Other very briefly treated subjects are pupils and apertures. Aberrations are described almost exclusively in terms of wave fronts and path differences, whereas some commentary on the effects of surface and aperture arrangements would put the reader in a better position for fruitful discussions with professional optical designers.

Nevertheless, Dr. Martin has encompassed a great deal of material in a minimum of space. The volume is superior to most of the introductory books on the subject.

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247—Eta Carina field
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249—Eta Carina nebula (enlarged)
250—Eta Carina nebula (greatly enlarged)
251—Eta Carina nebula (enlargement showing some of Dr. B. Bok's globules)
252—Planetary nebula (NGC 7293) in Aquarius
253—Barnard's "S"-shaped dark nebula
254—Milky Way north of Theta Ophiuchi
255—Dark Milky Way areas near Theta Ophiuchi
256—Milky Way near star 58 Ophiuchi
257—Great nebula region around Rho Ophiuchi
258—Dark lanes running east from Rho Ophiuchi
259—Region of Theta Ophiuchi
260—Nebulous group, NGC 6334 at bottom right
261—Great nebula near Pi and Delta Scorpii
262—Nebulosity and star clouds in Scorpius
263—Great nebula around Nu Scorpii
264—Overlying dark nebulous network (borders of Sagittarius and Scorpius)

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## NEW BOOKS RECEIVED

LE CIEL ET LA TERRE, *André Danjon, Pierre Pruvost,* and *Jules Blache,* editors, 1956, *Librairie Larousse,* 13 Rue du Montparnasse, Paris 6, France. 468 pages. 8,850 fr.

This is Volume III of the Encyclopédie Francaise. *The Sky and the Earth* contains a wealth of papers in French by many authors, treating of the earth, the solar system, the sun, stars, galaxies, and problems of stellar evolution.

WEATHER ELEMENTS, *Thomas A. Blair,* revised by *Robert C. Fite,* 1957, *Prentice-Hall.* 414 pages. $6.75.

This is the fourth edition of Blair's well-known elementary textbook on meteorology, revised and brought up to date by Professor Fite. The book is intended for both classroom and individual study. Amateur astronomers will be interested in the treatments of visibility, solar radiation, optical phenomena of the atmosphere, and other topics.

INTRODUCING ASTRONOMY, *J. B. Sidgwick,* 1957, *Macmillan.* 259 pages. $3.50.

Part I of this book consists of a rapid survey of the astronomer's domain, ranging from the moon to remote "island universes." Part II is largely devoted to descriptions of northern constellations, with details of many objects of interest visible to the naked eye or in binoculars.

SPACE, TIME, AND CREATION, *Milton K. Munitz,* 1957, *Free Press.* 182 pages. $3.75.

Professor Munitz explores some philosophical questions of cosmology. This book is intended for both the scientist and the lay reader, and is a companion to the author's *Theories of the Universe: From Babylonian Myth to Modern Science.*

DISCOVERIES AND OPINIONS OF GALILEO, *Stillman Drake,* translator, 1957, *Doubleday Anchor Books.* 302 pages. $1.25, paper bound.

Known for his English version of Galileo's *Dialogue Concerning the Two World Systems,* Mr. Drake has now translated four of the immortal Italian's shorter writings. These include his early telescopic observations of sunspots, the moon, and planets.

OUR FRIEND THE ATOM, *Heinz Haber,* 1956, *Simon and Schuster.* 165 pages. $4.95.

*Our Friend the Atom* is one of the de luxe Golden Book series for young readers. It is the literary counterpart of the Walt Disney motion picture of the same title, which was shown on television. Vividly illustrated, the book sketches the history of the atom and gives a look into the future of atomic energy.

TOWARD OUTER SPACE, *Franklyn M. Branley,* 1957, *Home Education Council,* P. O. Box 121, Ghent, N. Y. 16 pages. 25 cents, paper bound.

An associate astronomer at the American Museum-Hayden Planetarium briefly outlines the factual story of artificial satellites. He shows how they will mark the way to man's exploration of outer space. This well-illustrated booklet will be of special interest to schools and amateur astronomy clubs. It may be ordered from the publisher at the following bulk rates: 6 copies for $1.00; 19 to 100, 15 cents each; over 100, 12 cents each.

ERNEST RUTHERFORD: ATOM PIONEER, *John Rowland,* 1957, *Philosophical Library.* 160 pages. $4.75.

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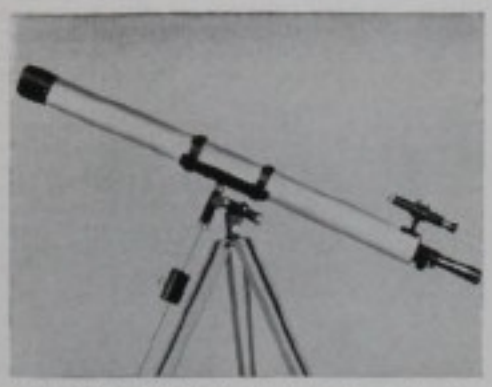

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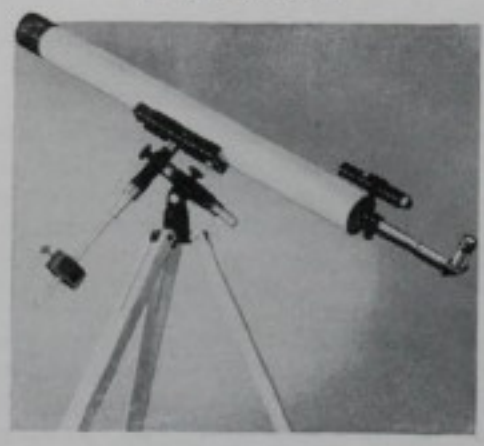

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**Stock #50,103-Y (for 2⅜" I.D. tubing) 12.95 ppd.**
**Stock #50,108-Y (for 3⅜" I.D. tubing) 13.95 ppd.**

## HUYGENS EYEPIECES

Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys!

**HUYGENS TYPE — STANDARD 1¼" DIAMETER**
**6-mm. (¼") Focal Length**
**Stock #30,063-Y ..... $8.50 ppd.**

**12.5-mm. (½") Focal Length**
**Stock #30,064-Y ..... $8.00 ppd.**

**COMBINATION EYEPIECE — 10-mm. and 20-mm.**
**Stock #30,065-Y ..... $9.00 ppd.**

## 7X — FINDER TELESCOPE — ACHROMATIC

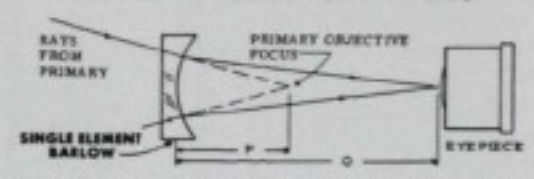
**Stock #50,080-Y Finder alone, less ring mounts ..... $9.95**
**Stock #50,075-Y Ring mounts per pr. ..... $3.95**

## HEAVY-DUTY EQUATORIAL MOUNT AND TRIPOD for 6"-8" REFLECTING TELESCOPE

Heavy cast base with sturdy 32" long hardwood legs. 1" shafts. Boston bronze bearings to provide a uniform film of lubrication over entire bearing surface and assure smooth operation. Big locking knobs 1¾" on both declination and polar axes. Polar axis variable for latitude adjustment. 12" cradle securely holds 3" to 10" tubes. Beautifully finished in baked black wrinkle paint. Legs can be removed easily for permanent post mounting. Height 38", weight 32 lbs.

**Stock #85,023-Y ..... $49.50 f.o.b.**

## DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER WITH A BARLOW LENS




WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power. The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q!

**Beautiful chrome mount.** We now have our Barlow lens mounted in chrome-plated brass tubing with special spacer rings that enable you to vary easily the power by sliding split rings out one end and placing them in other end. Comes to you ready to use. Just slide our mounted lens into your 1¼" I.D. tubing, then slide your 1¼" O.D. eyepieces into our chrome-plated tubing. Two pieces provided, one for regular focal length eyepieces and one for short focal length ones.

Remember, in addition to doubling and tripling your power, a Barlow lens increases your eye relief and makes using a short focal length eyepiece easier.

Don't fail to try one of these. Many people do not realize the many advantages of a Barlow and the much greater use they can get from their telescopes. Our Barlow has a focal length of —1⅝". We have received many complimentary letters about this lens. So sure are we that you will like it that we sell it under a 30-day guarantee of satisfaction or your full purchase price returned — no questions asked. You can't lose, so order today.

**Stock #30,200-Y Mounted Barlow lens $8.00 ppd.**

## ATTENTION — BEGINNERS AND JUNIOR ASTRONOMY CLUBS

To solve the problem of low-cost lenses of good quality for a beginner's telescope we have had these achromatic lenses designed and mass produced. Our first shipment is in. They are swell!

ACHROMATIC OBJECTIVE, 32-mm. diameter (1¼"), F. L. 31". (Will get 62X with ½" eyepiece; 124X with ¼" eyepiece.)
**Stock #30,201-Y ..... $2.50 ppd.**

ACHROMATIC OBJECTIVE, 42-mm. diameter (1-21/32"), F.L. 41". (Will get 41X with 1" eyepiece; 82X with ½"; and 164X with ¼".)
**Stock #30,202-Y ..... $4.00 ppd.**

UNMOUNTED SETS OF RAMSDEN EYEPIECE LENSES
**Stock #30,210-Y ..... ½" eyepiece set ..... $1.50**
**Stock #30,208-Y ..... ¼" eyepiece set ..... $1.75**

## PRISM STAR DIAGONAL

For comfortable viewing of the stars near the zenith or high overhead on refractor telescopes using standard size (1¼" O.D.) eyepieces, or you can make an adapter for substandard refractors. Contains an excellent quality aluminized right-angle prism. Tubes are satin chrome-plated brass. Body is black wrinkle cast aluminum. Optical path of the system is about 3½".

**Stock #70,077-Y ..... $12.00 ppd.**

## FUN WITH OPTICS

New booklet, 32 pages. Completely illustrated. Shows you how to build many types of optical instruments; plus lens primer showing various types of lenses and how they work, optical illusions, etc.

Simple, easy-to-follow directions for building astronomical telescopes, terrestrial telescopes, artist's drawing projectors, reflex slide viewers, magnifiers, miniature monoculars, transparency projectors and many other optical instruments.

No technical knowledge is needed. Youngsters or grownups can have a lot of fun learning about optics and building their own optical instruments using lenses, prisms, etc., purchased from us.

**Stock #9050-Y ..... $.50 ppd.**

## "MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our telescopes, polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

**Stock #50,074-Y ..... $16.25 ppd.**

## 6X FINDER TELESCOPE

Has crosshairs for exact locating. You focus by sliding objective mount in and out. Base fits any diameter tube — an important advantage. Has 3 centering screws for aligning with main telescope. 20-mm. diam. objective. Weighs less than ½ pound.

**Stock #50,121-Y ..... $8.00 ppd.**

## MISCELLANEOUS ITEMS

**KELLNER EYEPIECE** — 2" focal length (1¼" O.D.). Mount of black anodized aluminum.
**Stock #30,189-Y ..... $6.00 ppd.**

**60° SPECTROMETER PRISM** — Polished surfaces 18-mm. x 30-mm. — flat to ½ wave length.
**Stock #30,143-Y ..... $8.25 ppd.**

## BRASS TUBING

2 pieces, 3" long, slide fitting. Blackened brass. I.D. 1-3/16". O.D. 1-5/16".
**Stock #40,165-Y ..... $1.75 ppd.**

**30-day Money Back Guarantee as with all our Merchandise!**

**BE SURE TO GET FREE CATALOG "Y"**
Fantastic variety—never before have so many lenses, prisms, optical instruments, and components been offered from one source. Positively the greatest assembly of bargains in all America. Imported! War Surplus! Hundreds of other hard-to-get optical items. Write for Free Catalog "Y."

**ORDER BY STOCK NUMBER . . . SEND CHECK OR MONEY ORDER . . . SATISFACTION GUARANTEED!**

# BARRINGTON • NEW JERSEY

# AIRSPACED OBJECTIVES

## MOUNTED IN ALUMINUM CELLS f/15

We offer the lowest priced, hand-corrected, precision, American-made astronomical objective, *mounted in a black anodized aluminum cell.* Our reputation has been established over the years as the most reliable source of high quality astronomical lenses.

**"Those in the know" BUY FROM US BECAUSE:**

Each lens is thoroughly tested by us and is guaranteed to resolve two seconds of arc or better. They are corrected for the C and F lines, as is usual for visual refractors. The zonal spherical aberration and the chromatic variation of spherical aberration are negligible. The cell is machined to close tolerances so that it will fit directly over our standard aluminum tubing, eliminating any mounting problems.

3¼" diam., 48" f.l. (uncoated).. **$28.00**
Same as above with coating..... **$32.00**
4⅜" diam., 62" f.l. (uncoated).. **$60.00**
Same as above with coating..... **$69.00**

We can supply ALUMINUM TUBING for the above lenses.

## "BIG" ACHROMATIC TELESCOPE OBJECTIVES

We have the largest selection of diameters and focal lengths in the United States available for immediate delivery. These are perfect magnesium-fluoride coated and cemented Gov't. surplus lenses made of finest crown and flint optical glass. Not mounted. Fully corrected. Tremendous resolving power. They can readily be used with eyepieces of only ¼" focal length, thereby producing high powers. Guaranteed well suited for astronomical telescopes, spotting scopes, and other instruments. Gov't. cost up to $100.

| Diameter | Focal Length | Each | Diameter | Focal Length | Each |
|---|---|---|---|---|---|
| 54 mm (2⅛") | 254 mm (10")..... | $12.50 | 83 mm (3¼") | 660 mm (26")..... | $28.00 |
| 54 mm (2⅛") | 300 mm (11.8")..... | 12.50 | 83 mm (3¼") | 711 mm (28")..... | 28.00 |
| 54 mm (2⅛") | 330 mm (13")..... | 12.50 | 83 mm (3¼") | 762 mm (30")..... | 28.00 |
| 54 mm (2⅛") | 390 mm (15.4")..... | 9.75 | 83 mm (3¼") | 876 mm (34½")..... | 28.00 |
| 54 mm (2⅛") | 508 mm (20")..... | 12.50 | 83 mm (3¼") | 1016 mm (40")..... | 30.00 |
| 54 mm (2⅛") | 600 mm (23½")..... | 12.50 | 102 mm (4") | 876 mm (34½")..... | 60.00 |
| 54 mm (2⅛") | 762 mm (30")..... | 12.50 | 108 mm (4¼") | 914 mm (36")..... | 60.00 |
| 54 mm (2⅛") | 1016 mm (40")..... | 12.50 | 110 mm (4⅜")* | 1069 mm (42⅛")..... | 60.00 |
| 54 mm (2⅛") | 1270 mm (50")..... | 12.50 | 110 mm (4⅜") | 1069 mm (42⅛")..... | 67.00 |
| 78 mm (3⅛") | 381 mm (15")..... | 21.00 | 128 mm (5⅛")* | 628 mm (24¾")..... | 75.00 |
| 80 mm (3⅛") | 495 mm (19½")..... | 28.00 | 128 mm (5⅛") | 628 mm (24¾")..... | 85.00 |
| 81 mm (3⅜") | 622 mm (24½")..... | 22.50 | *Not coated | | |

● We can supply ALUMINUM TUBING for the above lenses. ●

## COATED BINOCULARS

American Type "Zeiss" Type

Beautiful imported binoculars, precision made, at a low, low price. Above we have pictured the two most popular types. The American type offers a superior one-piece frame and a clean design, pleasing to the eye. Complete with carrying case and straps. **Price plus 10% Federal tax.**

| SIZE | TYPE | C. FOCUS | IND. FOCUS |
|---|---|---|---|
| 6 x 15 | OPERA | — | $12.75 |
| 6 x 30 | "ZEISS" | $18.75 | 16.75 |
| 7 x 35 | "ZEISS" | 21.25 | 19.25 |
| 7 x 35 | AMERICAN | 23.50 | — |
| 7 x 35 | AMERICAN WIDE ANGLE 10° | 37.50 | — |
| 7 x 50 | "ZEISS" | 24.95 | 22.50 |
| 7 x 50 | AMERICAN | 32.50 | — |
| 8 x 30 | "ZEISS" | 21.00 | 18.25 |
| 10 x 50 | "ZEISS" | 30.75 | 28.50 |
| 20 x 50 | "ZEISS" | 41.50 | 39.50 |

## MONOCULARS

Brand new, coated optics, complete with pigskin case and neck straps.

| | Price | | Price |
|---|---|---|---|
| 6 x 30 | $10.00 | 7 x 50 | $15.00 |
| 8 x 30 | 11.25 | 16 x 50 | 17.50 |
| 7 x 35 | 12.50 | 20 x 50 | 20.00 |

**"MILLIONS" of Lenses, etc. Free Catalogue**

We pay the POSTAGE — C.O.D.'s you pay postage. Satisfaction guaranteed or money refunded if merchandise returned within 30 days.

## "GIANT" 3" TELESCOPE

**40 power** Special Price **$57.50**

You rarely find an instrument like this offered at so low a price. Here is another example of American ingenuity. Big 3" diameter achromatic coated objective which will give needle-sharp crystal-clear images. Focusing is a delight with the micrometer spiral focusing drawtube. Light-weight aluminum construction throughout, black crackle finish, length open 22 inches, closed 17 inches. This telescope gives an upright image—it is WONDERFUL for astronomy, SUPERB for long distances, EXCELLENT as a spotting scope.

## "GIANT" EYEPIECE

**WIDE ANGLE ERFLE** (68° Field) **EYEPIECE.** Brand new coated 1¼" E.F.L. Focusing mount. 3 perfect achromats, 1 13/16" aperture. **$12.50**

**WIDE ANGLE ERFLE** 1½" E.F.L. Brand new; contains Eastman Kodak's rare-earth glasses; aperture 2"; focusing mounts; 65° field... **$18.50**

**1¼" Diam. Adapter** for above eyepieces. **$3.95**

**LENS CLEANING TISSUE** — Here is a wonderful Gov't. surplus buy of Lens Paper which was made to the highest Gov't. standards and specifications.

500 sheets size 7½" x 11"..... **$1.00**

## MOUNTED EYEPIECES

The buy of a lifetime at a great saving. Perfect war-surplus lenses set in black anodized standard aluminum 1¼" O.D. mounts.

| F.L. | TYPE | PRICE |
|---|---|---|
| 12.5 mm (½") | Symmetrical..... | $ 6.00 |
| 16 mm (⅝") | Erfle (wide angle)..... | 12.50 |
| 16 mm (⅝") | Triplet..... | 12.50 |
| 18 mm (¾") | Symmetrical..... | 6.00 |
| 22 mm (2 1/32") | Kellner..... | 6.00 |
| 32 mm (1¼") | Orthoscopic..... | 12.50 |
| 35 mm (1⅜") | Symmetrical..... | 8.00 |
| 55 mm (2 3/16") | Kellner..... | 6.00 |

**COATED** 75 cents extra.

## ASTRONOMICAL MIRRORS

These mirrors are of the highest quality, polished to ¼-wave accuracy. They are aluminized, and have a silicon monoxide protective coating. You will be pleased with their performance.

| | Diam. | F.L. | Postpaid |
|---|---|---|---|
| Plate Glass | 3 3/16" | 42" | $ 9.75 |
| Pyrex | 4¼" | 45" | $13.50 |
| Pyrex | 6" | 60" | $25.00 |

## AN ECONOMICAL EYEPIECE

This mounted eyepiece has two magnesium-fluoride coated lenses 29 mm in diameter. It is designed to give good eye relief. It has an effective focal length of 1¼" (8x).

The eyepiece cell fits a 1¼" tube..... **$4.50**

## Aluminum Telescope Tubing

| O.D. | I.D. | Price Per Ft. |
|---|---|---|
| 2¼" | 2⅛" | $1.20 |
| 3⅜" | 3¼" | 1.75 |
| 4½" | 4⅜" | 2.75 |
| 5" | 4⅜" | 2.75 |

All tubing is shipped POSTPAID.

## Focusing Eyepiece Mounts Rack & Pinion Type

The aluminum body casting is finished in black crackle paint and is machined to fit all our aluminum tubing. Has a chrome-plated brass focusing tube, which accommodates standard 1¼" eyepieces.

| | | |
|---|---|---|
| For 2⅛" I.D. Tubing | Postpaid | $12.95 |
| For 3¼" I.D. Tubing | " | 12.95 |
| For 4⅜" I.D. Tubing | " | 12.95 |

REFLECTOR TYPE FOR ALL SIZE TUBING:
Complete with diagonal holder..... $ 9.95

## Aluminum Lens Cells Black Anodized

| Cell for Lenses | Cell Fits Tubing | Price |
|---|---|---|
| 54 mm Diam. | 2⅛" I.D. | $ 3.50 |
| 78 mm " | 3¼" " | 6.50 |
| 81 mm " | 3¼" " | 6.50 |
| 83 mm " | 3⅜" " | 6.50 |
| 110 mm " | 4⅜" " | 10.50 |

## 3X TELESCOPE

Makes a nice low-priced finder. Brand new; has 1" Achromatic Objective. Amici Prism Erecting System, 1⅜" Achromatic Eye and Field Lens. Small, compact, wt. 2 lbs.

Gov't. Cost $200. **$9.75**

## FIRST-SURFACE MIRRORS

| Size | Thickness | Postpaid |
|---|---|---|
| 14" x 16" | ¼" | $10.00 |
| 8" x 10" | ¼" | 4.25 |
| 4" x 5" | ¼" | 1.85 |
| 4" x 4" | ¼" | 1.50 |
| 1¼" x 1½" | ⅛" | .25 |

## RIGHT-ANGLE PRISMS

| | | | |
|---|---|---|---|
| 8 mm face.....ea. | $ .75 | 28 mm face.....ea. | $1.75 |
| 12 mm face.....ea. | .75 | 38 mm face.....ea. | 2.00 |
| 23 mm face.....ea. | 1.25 | 47 mm face.....ea. | 3.00 |

# A. JAEGERS

• THE GLASS HOUSE •
691 S MERRICK RD. LYNBROOK, N.Y.

# GLEANINGS FOR ATM's

CONDUCTED BY ROBERT E. COX

## A Split-Ring Mounting for a 12-inch Reflector

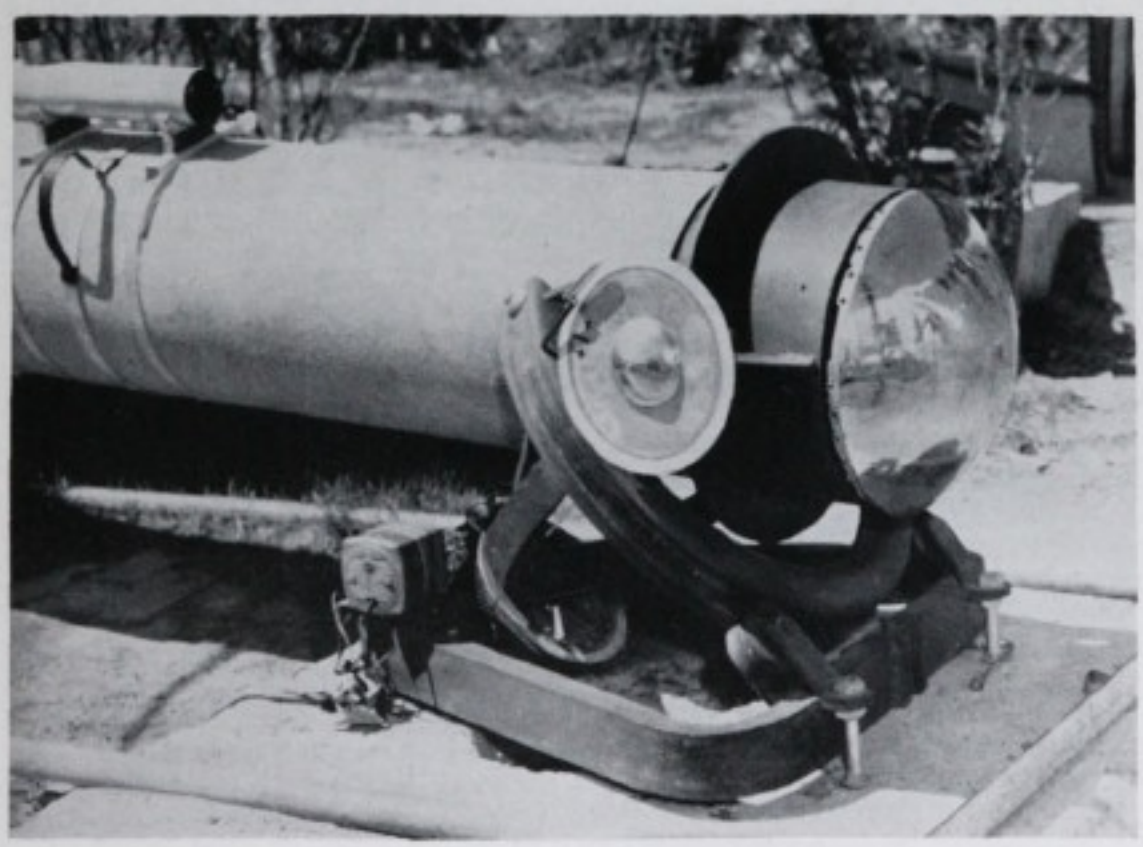
ALTHOUGH my 12-inch reflector is some seven feet long, I can use it on a split-ring mounting, which has some advantages over the fork type. The lightness of the fiberglass tube makes this possible. It is 13½" in diameter, and was constructed by wrapping layers of this material around a thin sheet-iron and wood mold.

The balance point of the tube is practically at the mirror's surface, because 200 pounds of lead were cast in the oversized hubcap at the lower end. This shows in the picture below. The tube is molded to a ⅛"-thick band or tube which holds the mirror cell. This is inserted into the mounting and can be rotated, but rotation of the eyepiece is seldom necessary except for observing toward the northern part of the sky.

The split-ring and yoke mounting are built around a World War I truck wheel from which the solid-rubber tire was burned off. The driving gear for right ascension is from the Boston Gear Works. The drive motor and worm gear were obtained for about $25 from the Barber Coleman Co., Rockford, Ill.

The finder is itself a reflector, and the eyepiece field contains a simple ring sight corresponding to the field of view in the main telescope. Because the finder can be aligned by the support screws of its primary mirror cell, the entire finder can be held securely to the main telescope. In these pictures, the finder is located at the

**Norman Herrett stands on the observing ladder of his 12-inch Newtonian reflector. The wind and light screen is made from awning canvas and it slides on a circular ring of pipe.**



**Here the Herrett telescope is in its storage position, ready to be covered by a low sliding shelter that runs on the large pipe rails. The hubcap counterbalance is at the end of the tube; the finder is in the upper left of the picture.**


**OPTICAL FLATS**

Pitch Polished, Beral Coated.

**Rectangular shape**

1⅜" x 1⅞"
½ wave $1.75 ea.
¼ wave $4.50 ea.
Postpaid.

**Elliptical shape**

Heavy edges to minimize temperature effects.
1¼" minor axis.
½ wave $4.00 ea.
¼ wave $6.50 ea.
Postpaid.

**BERAL COATINGS** — same optical characteristics as aluminum — mechanically more durable — not over-coated — may be removed without harming glass surface. Prices for Beral coating telescope mirrors: 4" diam.-$2.75, 6"-$3.50, 8"-$4.50, 10"-$6.50 and 12½"-$9.75 each, f.o.b. Skokie.

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**DELUXE PYREX**

**Reflecting Telescope Kits**

Our kits have PYREX mirror blank, PYREX tool the same thickness, ample supply of optical quality abrasives, fast polishing cerium oxide, red rouge and pitch. Packed in metal cans.

| *Size* | *Thickness* | *Price* |
|---|---|---|
| 4¼" | ¾" | $ 6.00 |
| 6" | 1" | $10.50 |
| 8" | 1½" | $18.75 |
| 10" | 1¾" | $33.65 |
| 12½" | 2⅛" | $59.95 |

ADD POSTAGE: 1st and 2nd postal zones from Detroit, add 5%; 3rd and 4th, add 10%; 5th and 6th, add 15%; 7th and 8th, add 20%. Or we will ship C.O.D.

*Send for free catalog of supplies, accessories, and refracting telescopes.*

**ASHDOWNE BROS.**
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**Everything for the Amateur**

**KITS ..... $4.50 up**

Thousands of our customers with no special training have built powerful precision telescopes with our quality supplies, instructions, and guidance.

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**ALUMINIZING**
Superior Reflecting Surface.
Guaranteed not to peel or blister.

**MIRRORS MADE TO ORDER**
**MIRRORS TESTED FREE**

**EYEPIECES CELLS | PRISMS BINOCULARS**

**PRECISION TRI-TURRET**

Holds 3 standard 1¼" O.D. eyepieces. Smooth turn to grooved notch aligns eyepiece precisely, ready to focus for various powers. Suitable for reflectors or refractors. **$15.75**

**ORTHOSCOPIC EYEPIECES**

**HIGHEST QUALITY • MADE IN U.S.A.**

Four-element design with fluoride COATED lenses, gives a wide flat corrected field.

Standard 1¼" O.D. — E.F.L. 6-8-12-16-24-mm. ..... Postpaid **$15.95**

*Write today for FREE Catalog.*

**Precision Optical Supply Co.**
1001-H East 163rd St., New York 59, N. Y.

## Precision Diagonals

You will get the best possible performance from your telescope with one of our clear **fused quartz** diagonals. Accuracy guaranteed 1/20 wave.

Ellipse 1.25" x 1.77" . . $11.00
Ellipse 1.5" x 2.12" . . $14.00

**Pyrex** diagonals, ⅛ wave accuracy.

Ellipse 1.25" x 1.77" . . $ 5.00
Ellipse 1.5" x 2.12" . . $ 8.00

Aluminum coating $1.00 extra.

*Send for our complete list of supplies, quartz mirrors, blanks, oculars, coatings, and accessories.*

**E & W OPTICAL CO.**
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Minneapolis 13, Minn.

## PYREX MIRROR MAKING KITS

Consist of PYREX mirror blank with either plate glass or additional Pyrex for tool. **Six** selected abrasives, pitch, rouge, and cerium oxide.

| Diameter | Plate-Glass Tool | Pyrex Tool |
|---|---|---|
| 6" | $ 9.50 | $10.50 |
| 8" | $12.50 | $18.00 |
| 10" | $21.50 | $32.00 |
| 12½" | $39.50 | $56.50 |

2 polished plano-convex lenses to make Ramsden eyepiece with each kit.

Postage Paid to 1st and 2nd postal zones from N. Y. Add 5% 3rd and 4th zones, 10% 5th and 6th zones. Add 15% 7th and 8th zones.

*Send for free catalog of optical supplies.*

**DAVID WILLIAM WOLF**
116-12 101st Ave. Jamaica 19, N. Y.

## EYEPIECE ATTACHMENT WITH RACK AND PINION

Takes standard 1¼" O.D. eyepieces. Rack and pinion smoothly machined from solid aluminum castings. Precisely fitted for smooth performance. Main tube is 1¾" long; sliding tube adds 2"; total movement 3¾". Your choice of gray or black crinkle finish.

**$15.95 ppd.**

## TRIGARTH TURRET

Just turn this newly designed device and easily improve the performance of your telescope. Holding three eyepieces of 1¼" O.D., the Trigarth Turret offers the observer a range of powers.

**$15.95 ppd.**

**TELESCOPE MIRROR CELLS**

6"-$7.00 8"-$11.50 10"-$35.00

**BUILD YOUR OWN TELESCOPE**

Prisms Lenses Eyepieces
Mirrors ground to your order.
Aluminizing—with Quartz Coating

**Satisfaction Guaranteed**

*Write for Free Catalog. Instructions, 10¢.*

**GARTH OPTICAL COMPANY**
P. O. Box 991 Springfield 1, Mass.


midpoint of the main tube, but the bands that hold it can be shifted to any desired location.

An important feature of this setup is the observing ladder, which is very light and extremely rigid, for its legs are independent and adaptable to uneven ground, spreading wide to any position. The ladder, made from electrical thin-wall conduit, can be constructed by anyone who knows simple brazing techniques. The ladder materials cost about $15.

Both pictures show the concrete slab on which the telescope is standing. Also resting on this slab are the ends of two large pipes that form the tracks on which rolls a "doghouse" cover for the telescope. The instrument must be turned down to point horizontally south before the cover can be rolled on.

This equipment was built entirely in my back yard, except for turning the ring and rolling the holder in which the tube sits. It has given me a great deal of observing satisfaction and, together with other smaller instruments, has been much used for public demonstrations. The handrails of the ladder help keep the visitors from trying to use the telescope itself for support.

NORMAN HERRETT
East Five Points
Twin Falls, Idaho

### A 12-INCH DALL-KIRKHAM

FINDING that my 9-inch f/11 Newtonian telescope was awkwardly long, I decided to make a more compact instrument, the 12-inch Dall-Kirkham compound telescope that is shown opposite. Its skeleton tube of angle iron is only 5′ 6″ long, yet the effective focal length is 360″.

A special cell was necessary because the mirror blank was a green porthole plate glass disk only 1¼″ thick. I designed the nine-point floating support system myself, finding later that my calculations match closely those of John H. Hindle in *Amateur Telescope Making*. The mirror-cell casting is aluminum. Three adjusting screws with hardened ball ends carry the triangular plates of the flotation system, the mirror resting on nine dome-headed rivets set in these plates.

The mirror is held in place by a stainless steel band and beading, this band having three bushed lugs for the studs and compression springs that maintain contact with the supporting system. Edge insulation is provided by a soft leather strap between the edge of the mirror and the metal band.

The finished mirror is 12″ full aperture, and has a focal length of 72″. Because the secondary mirror in the Dall-Kirkham design is spherical, the primary is only 81-per-cent parabolized. Rough grinding on the secondary was conscientiously carried out by my two daughters, 6 and 8 years old. A spherometer was practically indispensable for checking the radius of the secondary's convex surface.


## THE MARK III
### Sidereal Telescope Drive

Bodine Synchronous Motor, Automatic Clutch, Automatic Sidereal Time Circle requiring no calculation for location of objects, R.A. Indicator, Sidereal Time Indicator, Lifetime Quality, Precision Fabrication.

**Ramsden Eyepieces**
**Declination Circles**
**Hour-Angle Circles**

*Write for price list*

**H & W OPTICAL CO.**
654 Milwood Ave., Venice, Calif.

## LOW-EXPANSION ELLIPTICAL DIAGONALS

Aluminized, ⅛ wave.

| *Minor Axis* | |
|---|---|
| ¾" | $3.75 |
| 1" | 3.75 |
| 1¼" | 5.00 |
| 1½" | 6.50 |

## MODIFIED RAMSDEN EYEPIECES

½", ¾", 1¼", 2", 3", and 4" focal lengths. Attractively mounted in 1¼" O.D. silicon-aluminum bushings.

$5.50 each, $14.00 per set (any 3)

VERY FINEST WASHED ROUGE for the final stages of polishing and figuring.

In 4 oz. jar (wet)..... $1.80

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## TRIPLES 'SCOPE PERFORMANCE!

Sharper images, wider field, more light at higher powers! A startling statement positively proven in 16-page telescopic educational matter sent free on receipt of self-addressed long envelope bearing nine cents (9c) return postage.

**First, the Goodwin Resolving Power lens placed in front of eyepiece gives three times the magnification on each by lengthening your primary focal length angle up to three times, yet extends eyepiece out no more than two inches from normal. This alone sharpens definition.**

**Next, by achieving your highest powers on more comfortable low-power eyepieces, you lessen image deteriorations due to short-focus acute bending of the convergent beam, since all usual eyepieces are f/1 or less. Again sharper images from this highest precision lens.**

**Third, you get greater illumination and wider field by relieving tiny aperture restrictions of higher-power eyepieces.**

The Resolving Power lens is achromatic, coated, gives flat field sharp to the edge. Here is astonishment! Price $17.50 in 4" long adapter tube fitting standard 1¼" eyepiece holders ONLY (also adaptable to Unitrons. State if Unitron). Money back if not positively thrilled after two weeks trial! Used and praised by legions!

*No COD's—Colleges and Observatories may send purchase order.*

**FRANK GOODWIN**
345 Belden Ave., Chicago 14, Ill.

A rigid angle-iron base, bolted to a concrete foundation, supports C. G. Shuttlewood's f/30 compound reflector. Three knobs at the back of the mirror cell are for adjusting the metal plates that carry the nine-point mirror support system.

The cone of rays from the secondary is turned through 90° by a small prism, placing the eyepiece at the side of the tube almost opposite to the declination axis. This observing position is extremely convenient at all attitudes of the telescope.

The equatorial mounting has steel shafts 1¾″ in diameter, each axle running in a bronze sleeve and an angular-contact ball journal bearing. The fitted circles are 10″ in diameter, and a slipping clutch on the polar axis allows speedy changes of setting. I have a hand-drive control rod that is not shown in the picture.

Silvering of the primary and secondary mirrors was carried out in our kitchen, with the help of my wife, an enthusiast who is building her own 6-inch reflector. Collimation of the compound reflector's optics was rather exasperating, but was finally achieved with the aid of a friend.

The instrument has been worth the effort. The first observing test was on a 3″ image of the sun at the secondary focus, complete with well-defined sunspots. For lunar observations I have used powers of 240x, 480x, and, on one very fine night, 960x.

C. G. SHUTTLEWOOD
49 Bringhurst Rd., New Parks
Leicester, England

LAFAYETTE

SAVES YOU MONEY ON THESE DIRECT OPTICAL IMPORTS

IMPORTED

REFRACTING ASTRONOMICAL TELESCOPE WITH TRIPOD AND CARRYING CASE

- Four Eyepieces—40X, 64X, 89X, 100X
- 800-mm. Focal Length
- 2⅜" Objective Lens
- Regularly $125.00

Fully corrected and coated lenses afford maximum brilliance and clarity. Heavily chromium-plated brass used in moving parts. Beautifully finished duraluminum tube. Focused by means of rack and pinion. Erecting prism for terrestrial observation and diagonal prism for astronomical may be used with any of the eyepieces. Fork-type altazimuth mounting with tension adjustments. Includes view finder with 4X crosshair eyepiece — sun glass — star diagonal eyepiece — erecting prism eyepiece — wooden tripod with chain brace — complete in compact, hinged wooden carrying case. Weight of telescope, tripod and case — each approximately 6 lbs. Total shpg. wt. 25 lbs.

F-102 COMPLETE SET ..... NET 69.50

Famous "Zeiss"-type

PRISM BINOCULARS COATED LENSES

- All metal construction
- Complete with leather case and straps

Add 10% Fed. Tax

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| F-182 | — 6 x 15 Ind. Focus..... | NET | 10.75 |
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| F-15 | — 7 x 35 Ind. Focus..... | NET | 17.95 |
| F-183 | — 7 x 35 Center Focus..... | NET | 20.95 |
| F-184 | — 7 x 35 Center Focus..... (Wide Angle)... | NET | 29.50 |
| F-103 | — 7 x 50 Ind. Focus..... | NET | 21.50 |
| F-164 | — 7 x 50 Center Focus..... | NET | 24.95 |
| F-117 | — 10 x 35 Center Focus..... | NET | 23.95 |
| F-104 | — 12 x 50 Ind. Focus..... | NET | 27.95 |
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30-Power 60-mm. Spotting Scope

Binocular-type focusing. Prismatic lens system. Coated lenses. Weighs only 11 ozs., 12½" long. Field of view is 85 feet at 1000 yds. Spot .22-caliber bullet holes at 200 yards. Threaded metal dust cover screws on over objective lens. Features 11½" tripod and adjustable mount. Weighs only 1½ lbs. including tripod. With leather carrying case, mount and tripod.

F-149 ..... 17.95

ABNEY CLINOMETER LEVEL

A finely made surveying instrument of professional quality. Made entirely of brass. The Abney topographic level enables the user to determine ground elevation, measure degrees of slope or inclination, run a level line, and so forth. Permits preliminary surveying with little or no experience. Fine prismatic system. Arc scale is divided into 60 degrees both sides of zero. Vernier scale reads to 10 minutes. Includes leather case and strap. Imported to save you 50% of regular cost. Shpg. wt. 3 lbs.

F-138 ..... Net 8.95

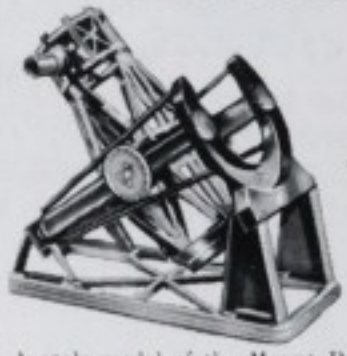
30X ALL-PURPOSE TELESCOPE

- WITH TRIPOD!
- 40-MM. COATED ACHROMATIC OBJECTIVE!
- 59-FOOT FIELD AT 1000 YARDS!
- BODY OF DURALUMINUM AND BRASS!

See the craters on the moon! Watch planes — ships—birds and animals! Spot .22 caliber bullet holes at 200 yds.! A typical Lafayette buy! Full two feet long closed—27½" extended. Achromatic coated objective is 40 mm. in diameter, clear aperture is 38 mm., or 1½". Body diameter is 1⅜". Lens erecting system gives upright image. Focuses from 40 feet to infinity. Adjustable horizontal swing tension and adjustable azimuth tension knob. Can be used with camera tripod. Smooth sliding draw-tube focusing — with coated eyepiece lens. Complete with 11½" tripod and bracket. Shpg. wt. 5 lbs.

F-139 ..... Net 11.95

WORKING SCALE MODEL OF MOUNT PALOMAR GIANT TELESCOPE



- BAUSCH & LOMB REFLECTOR MIRROR

A scale model of the Mount Palomar 200-inch — and it really works! Bausch & Lomb optically ground and polished primary mirror. Approximately 30X — just the thing for space-minded children. Educational — interesting — and fun to use. Rigid design — of high-impact styrene. Complete kit — including instructions and illustrated "Star Guide." Shpg. wt. 5 lbs.

F-223 ..... Net 8.39

Fully assembled — ready to use, as described above but not in kit form. Shpg. wt. 5 lbs.

F-224 ..... Net 10.49

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Also presenting sun projectors of advanced styling.

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**Complete Telescopes**

**Our Latest with**

**Dual Finder that swings to either side of eyepiece. Find object with ease, east or west of your meridian.**

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**For details and price list, write**

**C. C. YOUNG CO.**
**25 Richard Road, East Hartford 8, Conn.**



**Read This Advertisement**

Here is a combination of a Barlow and a particular ocular which gives outstanding results. It consists of our new Barlow and our 16.3-mm. (⅝" focal length) Erfle eyepiece. While the Barlow was not specifically designed to work with this eyepiece, it does so to an astonishing degree. All images are sharp and hard to the very edge of the field.

The Barlow gives magnification up to slightly over three times that of the ocular alone. It is achromatic, coated, and mounted to the U. S. standard size of 1.230 inches.

The modified Erfle eyepiece has a field of 75 degrees with excellent eye relief. The combination gives the equivalent focal length of slightly under 6 mm. Many users state it is far superior to any shorter focal length ocular of equivalent magnification.

The Barlow sells for $16.00 postpaid, and the Erfle for $14.75 postpaid. Both are guaranteed to perform as stated above or money refunded.

**ORTHOSCOPIC OCULARS—All hard coated, standard 1¼-inch outside diameter.**

| | | | | | |
|---|---|---|---|---|---|
| 28-mm. | $15.00 | 10.5-mm. | $16.25 | 4-mm. | $17.25 |
| 16.3-mm. (Erfle) | $14.75 | 7-mm. | $17.25 | Barlow 3x | $16.00 |

*Telescopics*

**1000 North Seward Street**
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Warranted to equal or surpass any oculars obtainable anywhere or money refunded.

Finished mirrors, mirror kits, spiders, elliptical flats, focusing devices, aluminizing.

**Send for catalogue.**

**Magnusson Heavy-Duty Mounting**

***Look at these features—***

1. Latitude adjustment.
2. 1¼" x 17" declination shaft.
3. Ball-bearing polar-axis shaft, 1½" on north end —1" on south end x 12" long. Suitable for clock drive.
4. High tensile aluminum black-finish castings, with solid-steel shafts.
5. 11-pound cast-iron balance weight.
6. Locking screws on polar and declination axles.
7. 5" brass setting circles with pointers.
8. Weight approximately 38 pounds complete.
9. Custom-made saddle to fit your telescope.

State size of tube, up to 12". Tripod not included.

With setting circles ..... $125.00 f.o.b. Arvada
Without circles ..... $96.00 f.o.b. Arvada

**SETTING CIRCLES** — State hole sizes.

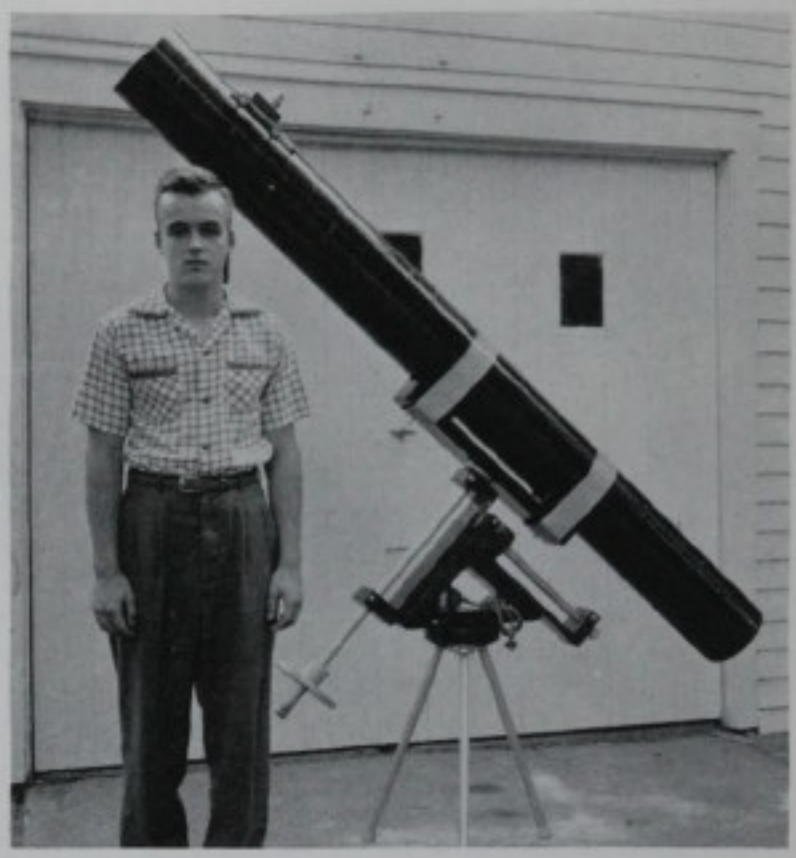
| | *Aluminum* | *Brass* |
|---|---|---|
| 5" circles, set of two | $12.00 | $15.60 |
| 6" circles, set of two | $13.00 | $16.90 |
| 8" circles, set of two | $20.00 | $26.00 |

**O. MAGNUSSON**
14560 West 52nd Ave., Arvada, Colorado


## AN INEXPENSIVE REFLECTOR

THE budget of a high school student does not permit spending much money on telescopes. Nevertheless, I built the 6-inch f/14 reflector shown here at a cost of $37.93, including $17.37 for mirror materials and $12.05 for eyepieces.

The long focal length was selected for ease of figuring and comparative freedom from optical aberrations. My grinding stand was a large barrel partially filled with water. No major obstacles were encountered until I tried to channel the pitch lap. Finally I turned to the rubber mold lap described by Allyn J. Thompson in *Making Your Own Telescope* (page 53). Once the mold was made, as many laps as required could be turned out easily.



**Clean design and careful workmanship are evident in this f/14 reflector of 6-inch aperture built by young amateur Courtney Cook. When not in use it is stored in the upper part of the garage just behind it.**

A wooden plate fitted into the end of the tube carries the wooden mirror cell, with three bolts and springs to hold the plate and cell apart. The mirror is adjusted by nuts on these bolts.

The diagonal mirror is glued to a block of wood held in place by a single bolt, which is secured to the wall of the tube by two nuts. The eyepiece adapter is a section of 1¼" pipe, and is threaded into a large nut set in a block of wood. This simple device permits critical focusing.

For the tripod legs, I used ¾" pipe; the tripod head is of wood. The equatorial axles are also ¾" pipe, turning in wooden bearings. Each bearing consists of two blocks of wood set 18" apart. Axle holes were drilled, and ground to a proper fit with carborundum; these bearing surfaces are coated with paraffin and lubricated with oil.

The completed telescope weighs about 50 pounds, yet by means of a system of pulleys it can be stored in one piece above the car in our garage.

I found that the quality and rigidity of the mounting, as well as the general durability of the telescope, did not have to be sacrificed for economy. Ordinary materials and hand tools, together with care and patience, produced an acceptable job.


COURTNEY COOK
409 E. Springfield
Champaign, Ill.

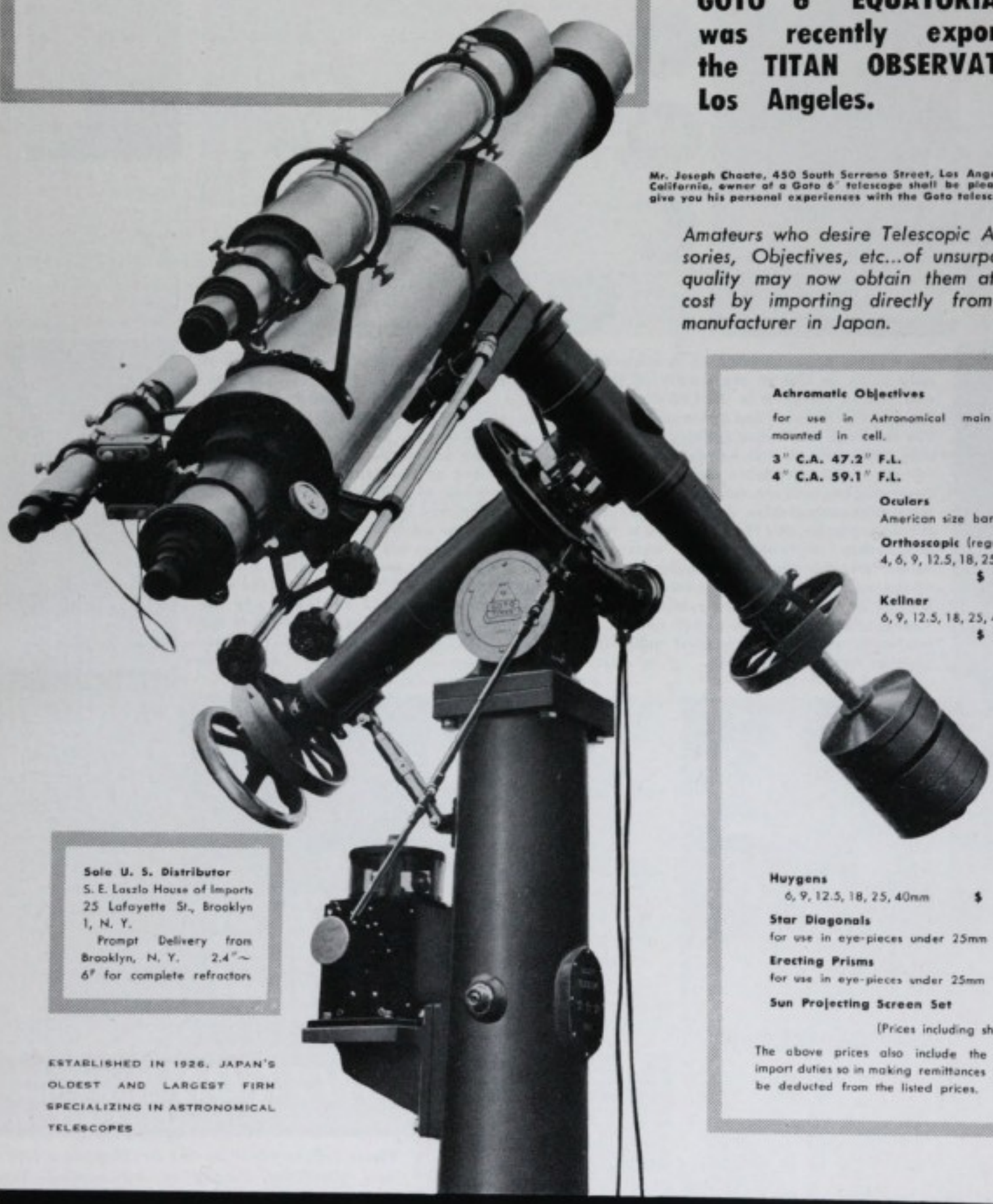
# Japan's Finest Telescopes now available for American Astronomers

GOTO
TOKYO

**This complete GOTO 6″ EQUATORIAL was recently exported to the TITAN OBSERVATORY in Los Angeles.**

Mr. Joseph Chaote, 450 South Serrano Street, Los Angeles 5, California, owner of a Goto 6″ telescope shall be pleased to give you his personal experiences with the Goto telescope.

*Amateurs who desire Telescopic Accessories, Objectives, etc...of unsurpassed quality may now obtain them at low cost by importing directly from the manufacturer in Japan.*



**Achromatic Objectives**

for use in Astronomical main telescopes, mounted in cell.

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| 3″ C.A. 47.2″ F.L. | $ 61.50 |
| 4″ C.A. 59.1″ F.L. | $ 137.00 |

**Oculars**
American size barrel.

**Orthoscopic** (regular type)
4, 6, 9, 12.5, 18, 25mm
**$ 14.40** each

**Kellner**
6, 9, 12.5, 18, 25, 40mm
**$ 12.90** each

**Huygens**
6, 9, 12.5, 18, 25, 40mm **$ 6.70** each

**Star Diagonals**
for use in eye-pieces under 25mm **$ 10.90**

**Erecting Prisms**
for use in eye-pieces under 25mm **$ 11.90**

**Sun Projecting Screen Set** **$ 11.90**

(Prices including shipping costs)

The above prices also include the anticipated import duties so in making remittances 25% should be deducted from the listed prices.

**Sole U. S. Distributor**
S. E. Laszlo House of Imports
25 Lafayette St., Brooklyn 1, N. Y.
Prompt Delivery from Brooklyn, N. Y. 2.4″~6″ for complete refractors

ESTABLISHED IN 1926, JAPAN'S OLDEST AND LARGEST FIRM SPECIALIZING IN ASTRONOMICAL TELESCOPES

**GOTO OPTICAL MFG. CO.**
1-115 SHIMMACHI, SETAGAYA-KU, TOKYO, JAPAN

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GOTOPTIC TOKYO

# UNITRON

**Yours — FREE — for the asking!**

## The UNITRON Catalog of ASTRONOMICAL TELESCOPES

*including the*

## OBSERVERS GUIDE

**The sample pages shown here in miniature only begin to hint at the wealth of facts and figures included in UNITRON's colorful, 38-page Catalog and Observer's Guide. The full-page illustrated articles on astronomy are crammed with helpful information — not readily available elsewhere — on observing the heavens, telescopes and their mountings, accessories, amateur clubs, astrophotography, and the like. There is even a glossary of telescope and observing terms. Whether you are a beginner or an advanced amateur you will certainly want a copy of this remarkable publication for your bookshelf. Use the handy coupon, a postcard, or letter to request your free copy of this valuable guide.**

**Those who are considering the purchase of a telescope will find it especially worth while to learn more about the distinguished line of UNITRON Refractors and Accessories which play so important a role in astronomy today. For only by a careful comparison of the features, quality, and performance of different instruments can the prospective buyer insure that his telescope will be worthy of his investment and of the time he will devote to observing. It's truly easy to own a UNITRON. A down payment of only 10% puts you at the controls and you have 12 months to pay the balance. Full information is included in the UNITRON Catalog. Send today for your free copy.**

**UNITRON** INSTRUMENT DIVISION OF UNITED SCIENTIFIC CO.

204-206 MILK ST • BOSTON 9, MASSACHUSETTS

Please rush to me at no cost or obligation a copy of the new UNITRON Catalog of Astronomical Telescopes including the Observers Guide.

Name .....

Street .....

City ..... State .....

PLEASE PRINT

# UNITRON announces the winners in the "Ten Per Cent" Limerick Contest

In case you haven't heard, the down payment on UNITRON Refractors has been reduced to 10%. Here are the winners in the UNITRON Limerick Contest, whose versifications of this notable event have won them these grand UNITRON prizes.

**First Prize:**
**UNITRON 2.4" Altazimuth Refractor**

**Old Omar, interviewed in his tent,**
**Quoted this of the new "ten per cent."**
**"To the wine, bread and thou**
**Must be added, I vow,**
**A UNITRON to give me content."**

*Robert F. Lomprey, Manitowoc, Wisc.*

**Second Prize:**
**DUETRON Double Eyepiece**

**When that UNITRON comes to your door,**
**You are joyously thrilled to the core.**
**That ten per cent plan**
**Starts a service to man**
**That has never been equalled before.**

*Thomas Bloor, 223 Norton St., New Haven, Conn.*

**Third Prize:**
**UNITRON 42-mm. View Finder**

**To silver a mirror concave**
**Is enough to make anyone rave.**
**But with UNITRON's Plan**
**Of a tenth down, I can**
**Use my telescope mirror to shave.**

*J. Herbert Speer, Lima, Ohio*

**Fourth Prize:**
**UNITRON 30-mm. View Finder**

**An eloquent female expounder**
**Did stammer and stutter and flounder,**
**For the ten per cent plan**
**Of the UNITRON clan**
**Was enough to amaze and astound her.**

*David Brice, 201 Texas St., Sulphur Springs, Texas*

☆ ☆ ☆

As explained in more detail on the back cover of this issue, 11 "fifth prizes" have been awarded. The following winners, who are listed in alphabetical order, each receives a UNITRON 23.5-mm. view finder for his efforts.

**It did seem but a dream to behold,**
**A large UNITRON I had been sold.**
**But it's actual, real!**
**One-tenth down was the deal**
**That made heavenly wonders unfold.**

*G. S. Axelby, 211 Coronet Drive, N. Linthicum, Md.*

**The UNITRON makers of Mass.**
**Have a 'scope all alone in its class.**
**And though great its renown**
**For just ten per cent down**
**You can purchase this wonderful glass.**

*J. D. Beaty, 1808 St. Mary's St., Raleigh, N. C.*

**Have you heard that there's been quite a slash**
**In amount of the actual cash**
**That is needed to buy**
**That fine stargazer's eye,**
**UNITRON, the great optical flash!**

*O. F. H. Bert, 28 N. Lincoln St., Washington, Pa.*

**There was a creature on Venus**
**Who wanted a UNITRON to see us.**
**He paid down ten per cent**
**But no more has he sent.**
**No moon, no months, so why pay us?**

*B. Dzula, 54 Charles St., Clifton, N. J.*

**There was a young man of Ceylon,**
**Who was praising his fine UNITRON —**
**"Now the small ten per cent**
**Is the new down payment**
**For the 'scope with all pro and no con!"**

*A. Hornsberger, 775 Sumac Lane, Winnetka, Ill.*

**My joy runneth over my cup!**
**UNITRON has me pleased as a pup . . .**
**For it's all over town:**
**The down payment is down!**
**Now less down helps more people look up!**

*D. Harrington, 208 3rd Ave. SW, Pipestone, Minn.*

**Said Saturn to Mars, "What a plight**
**That deliveries can't reach to this height,**
**Or, for ten per cent down**
**For UNITRON of renown,**
**We'd be looking at earthlings tonight."**

*C. Kisslinger, 7734 Elene Ave., University City, Mo.*

**For features that are up to the minute,**
**And resolution that's up to Dawes' limit,**
**Plunk your ten per cent down,**
**On the best 'scope in town,**
**The UNITRON — that's what will give it.**

*R. Larsen, 6824 York Rd., Parma Hts., Ohio*

**There once went a Moon-maid named Zater**
**Sun-bathing, from crater to crater —**
**But an Earthling named Brown,**
**With just ten per cent down,**
**Bought a UNITRON 'scope to locate her.**

*G. Lasley, 2738 Lafayette St., St. Joseph, Mo.*

**Typed the Edsac to Univac one night,**
**Put this fact in your registers right:**
**The down payment, for men,**
**In per cent now is ten,**
**For the UNITRON starry views bright.**

*R. Schreglman, 40 Olcott Ave., Buffalo, N. Y.*

**Said Lyra to Cygnus the Swan:**
**"Our era of privacy's gone.**
**All eyes now will pry,**
**It's so easy to buy**
**A UNITRON, ten per cent down."**

*M. L. Seaman, 671 Kenilworth Ave., Glen Ellyn, Ill.*

## CONFIRMATION of a RUMOR

Our attention has been directed to a rumor which has been epicycling in astronomical circles to the effect that UNITRON — patron of the arts — also sells telescopes and accessories. We feel it necessary to state that all reports to this effect are definitely *true*. A copy of the UNITRON Catalog of Astronomical Telescopes including the Observers Guide (described on the facing page) will be sent to those who require further proof, and as added evidence we list the following UNITRON models:

| | |
|---|---|
| 1.6" ALTAZIMUTH ($7.50 Down) with eyepieces for 78x, 56x, 39x | $75 |
| 2.4" ALTAZIMUTH ($12.50 Down) with eyepieces for 100x, 72x, 50x, 35x | $125 |
| 2.4" EQUATORIAL ($22.50 Down) with eyepieces for 129x, 100x, 72x, 50x, 35x | $225 |
| 3" ALTAZIMUTH ($26.50 Down) with eyepieces for 171x, 131x, 96x, 67x, 48x | $265 |
| 3" EQUATORIAL ($43.50 Down) with eyepieces for 200x, 131x, 96x, 67x, 48x | $435 |
| 3" PHOTO-EQUATORIAL ($55.00 Down) with eyepieces for 200x, 171x, 131x, 96x, 67x, 48x | $550 |
| 4" ALTAZIMUTH ($46.50 Down) with eyepieces for 250x, 214x, 167x, 120x, 83x, 60x | $465 |
| 4" EQUATORIAL ($78.50 Down) with eyepieces for 250x, 214x, 167x, 120x, 83x, 60x, 38x | $785 |
| 4" PHOTO-EQUATORIAL ($89.00 Down) eyepieces for 250x, 214x, 167x, 120x, 83x, 60x, 38x | $890 |
| 4" EQUATORIAL with clock drive ($98.50 Down), new Model 160V | $985 |
| 4" EQUATORIAL with clock drive and metal pier ($107.50 Down), new Model 166V | $1075 |
| 4" PHOTO-EQUATORIAL with clock drive and astro-camera ($117.50 Down), with eyepieces for 250x, 214x, 167x, 120x, 83x, 60x, 38x, 25x | $1175 |
| 4" PHOTO-EQUATORIAL with clock drive, pier, astro-camera ($128.00 Down), eyepieces for 375x, 250x, 214x, 167x, 120x, 83x, 60x, 38x, 25x | $1280 |

*Higher- and lower-power eyepieces available for all models. Prices include basic accessories, tripod and mounting, fitted wooden cabinets, and operating instructions. Additional accessories available to add further to your observing pleasure. All UNITRON instruments are fully guaranteed for quality, workmanship, and performance, and must meet with your approval, or your money back.*

## COMING NEXT MONTH UNITRON'S 6" REFRACTOR

Here is the news for which so many of you have waited. Next month, UNITRON's new 6" Photo-Equatorial Refractor will be formally announced with complete specifications and price. Those who are not yet quite ready for an instrument of this size will, nevertheless, want to learn more about this remarkable 6" Refractor, with its 2.4" view finder, 3" guide telescope, and 4" astro-camera. (Perhaps by next month we will be able to get the 1.6" into the act.)

## UNITRON — the $64,000 Telescope

As this ad was being prepared, Robert Strom, of the Bronx, New York City, had just added $42 thousand to his previous winnings of $48 thousand on Revlon's TV program, "The $64,000 Question." The major part of Robert's question consisted in identifying the point in the sky at which a UNITRON 3" Equatorial Refractor was pointing, by computing from the readings on the setting circles. For the benefit of those who may have been observing the skies rather than the screen on that memorable evening, we will picture Robert in action next month.

**UNITRON** INSTRUMENT DIVISION of UNITED SCIENTIFIC CO.
204-206 MILK STREET BOSTON 9, MASSACHUSETTS

**Follow the Stars Wherever You Go**

**with a BALscope TELESCOPE**

Now you can enjoy astronomy whenever you wish—wherever you are, thanks to the excellent portability of the BALscope 60mm telescope. Why, it's so compact (16½" long, weighs 48 ounces) you can carry it anywhere, and it can be mounted on any pan-head camera tripod with a B&L tripod adapter.

Focusing the BALscope is simple yet precise with its unique prism-focusing system. Its high light-gathering power and lack of stray light enables you to observe stars down to the tenth magnitude on moonless nights. Four easily interchangeable eyepieces ranging from 15X to 60X provide excellent results—from Star Clouds to Double Stars. Of course, you'll find the BALscope is also the finest terrestrial telescope available.

BAUSCH & LOMB TIME PAYMENT PLAN

You can own the BALscope for just pennies a day under new Time Payment Plan offered by B&L dealers everywhere.

**$6.18** per mo.
$115 cash price

**WRITE** for free copy of G-36, "The Telescope." Tells all about the BALscope and how it is so ideally suited to amateur astronomy. Tells also of many ways your family will enjoy the BALscope.
Bausch & Lomb Optical Co.,
25817 Lomb Pk., Rochester 2, New York.

BAUSCH & LOMB
SINCE 1853

# OBSERVER'S PAGE

**Universal time is used unless otherwise noted.**

## The Widespread Aurora of March 1-2

MANY REPORTS have been received of the brilliant and striking display of northern lights on the night of March 1-2. It was observed over most of the United States, including regions as far south as New Mexico.

At Winston, New Mexico, a red glow in the northeast, that Raymond Schmidt first sighted at 11:35 p.m. Mountain standard time, soon spread into the northwest. It then appeared as a green background extending from 25° above the horizon to within a few degrees of the zenith, crossed by white rays which drifted westward. This display lasted half an hour, and then resumed at 12:35 a.m.; at 4:40 in the morning a similar display was seen by Mr. Schmidt.

Three observers of the Great Plains Astronomical Society made systematic observations and took photographs through the night. Stephen R. Sinotte and Mike Kaiser worked at Keokuk, Iowa, and Charles Martens observed from Charles City, Iowa. Mr. Sinotte first noted a bright glow in the northern sky at 10:30 p.m. Central standard time. Later homogeneous bands were seen, and by 1:00 a.m. flaming aurora was present—quickly moving waves of light traveling up the sky. At this time a corona was forming, centered about 10 degrees south of the zenith. By 1:30 some 65 per cent of the sky was covered with northern lights, consisting mainly of draperies, pulsating rays, and flaming aurora. Mr. Martens set the climax of the display at 2:30 a.m., when the corona was a predominantly yellow and green ring about 30 degrees in diameter. Mr. Sinotte noted that at about 2:15 the color in the northwest changed to pink-red, later to deep orange-red, and that by 3:00 the flaming aurora had died.

The display extended all the way to the southern horizon when Thomas B. Butler watched at Mt. Sinai, New York, from 1:20 to 1:55 a.m. Eastern standard time. Ray forms predominated, diverging from a corona about 15° south of the zenith; there were also pulsating and arc features.

At Greeley, Colorado, Dr. J. R. Otoupalik watched the northern lights from 10:00 p.m. to midnight, Mountain standard time. Its colors made it the most beautiful display he had seen in many years; it covered the whole northern heavens from east to west and later spread far to the south. He noted particularly the easy visibility of even faint stars through extremely bright auroral features.

## COMET AREND-ROLAND

THE end of April and early May will probably give the best views of Comet Arend-Roland, if you are observing from the Northern Hemisphere. In the first part of April this comet was brighter, but lost in the glare of the sun. After perihelion, which occurred April 8th, Comet Arend-Roland moved rapidly northward into the early evening sky. As shown by the chart on page 245 of the March issue, the comet will be in Camelopardalis during May, a circumpolar object.

From the Pic du Midi Observatory in France comes word that the comet may not become quite as bright as was earlier hoped. *Circular* 1588 of the International Astronomical Union gives the following visual magnitude predictions, based upon photoelectric measurements in February at Pic du Midi: April 2, −0.1; 12, −1.4; 22, +0.4. May 2, +3.2; 12, +5.5; 22, +7.3. June 1, +8.6; 11, +9.7; 21, +10.7.

The comet's motion during May is shown by the following extract from the ephemeris computed by M. P. Candy (IAU *Circular* 1585). Given are the right ascension and declination of the comet (1950 co-ordinates) for 0:00 UT of every fourth day:

May 2, $4^h\ 05^m.9$, +57° 52′; May 6, $4^h\ 56^m.8$, +61° 24′; May 10, $5^h\ 41^m.0$, +63° 00′; May 14, $6^h\ 17^m.7$, +63° 34′; May 18, $6^h\ 47^m.6$, +63° 35′; May 22, $7^h\ 12^m.1$, +63° 18′; May 26, $7^h\ 32^m.5$, +62° 54′; May 30, $7^h\ 49^m.9$, +62° 25′. June 3, $8^h\ 05^m.0$, +61° 56′; June 7, $8^h\ 18^m.3$, +61° 27′.

The increasing proximity of the comet to the sun caused a general interruption in observations, beginning in late February. David D. Meisel, Fairmont, West Virginia, made a long series of drawings of the comet during January and Feb-

**This drawing of Comet 1956h was made by David D. Meisel on the night of February 17-18, using powers of 40x and 80x, on an 8-inch reflector.**

ruary, using an 8-inch reflector. His last view was during the evening twilight of February 21st, when the comet appeared of magnitude 8.5, with a tail ½ degree long.

At Manhattan, Kansas, Walter Scott Houston on the 26th of February saw the comet faintly, nearly blotted out by the zodiacal light. The last magnitude measurement at Pic du Midi was the following night. (The result was 7.3, in yellow light.) Perhaps some even later pre-perihelion sightings will be reported by Southern Hemisphere watchers.

## A BRILLIANT METEOR IN THE SOUTH

Charles Prescott, of Houston, Texas, observed the fireball that startled many people in a wide area of the South, from Florida to Texas, at 10:03 p.m. Central standard time, Friday, March 15th. He writes:

"The fireball first appeared in a direction about five degrees north of east, at an altitude slightly less than that of the full moon. It disappeared just above my horizon to the south of east, possibly behind a cloud bank. Brilliant white at the beginning, the meteor turned immediately to blue, the color of an electric arc. Halfway to the horizon, it took on an orange color. It had a very heavy train behind it. This fireball lit up the sky to match the moon's light for about four seconds. It was beautiful!"

Reports on the meteor were sent to newspapers by observers in the states of Arkansas, Oklahoma, and Missouri, as well as Texas and Louisiana. Most of these indicated that the meteor's path ended over the Gulf of Mexico.

## SUNSPOT NUMBERS

**February 1,** 68, 105; **2,** 58, 114; **3,** 70, 73; **4,** 106, 103; **5,** 84, 94; **6,** 102, 110; **7,** 104, 123; **8,** 126, 136; **9,** 150, 144; **10,** 119, 126; **11,** 98, 113; **12,** 108, 116; **13,** 103, 100; **14,** 114, 115; **15,** 143, 120; **16,** 136, 139; **17,** 121, 127; **18,** 121, 120; **19,** 99, 109; **20,** 92, 90; **21,** 97, 111; **22,** 123, 115; **23,** 98, 126; **24,** 116, 126; **25,** 116, 127; **26,** 102, 128; **27,** 106, 133; **28,** 121, 126. Means for February: 107.2 American, 116.8 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by Dr. Sarah J. Hill from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

Dr. M. Waldmeier has communicated the following definitive monthly averages for 1956, which differ from his preliminary Zurich numbers by the inclusion of observations from additional stations: January, 73.6; February, 124.0; March, 118.4; April, 110.7; May, 136.6; June, 116.6; July, 129.1; August, 169.6; September, 173.2; October, 155.3; November, 201.3; December, 192.1. The definitive Zurich yearly mean for 1956 was 141.7.


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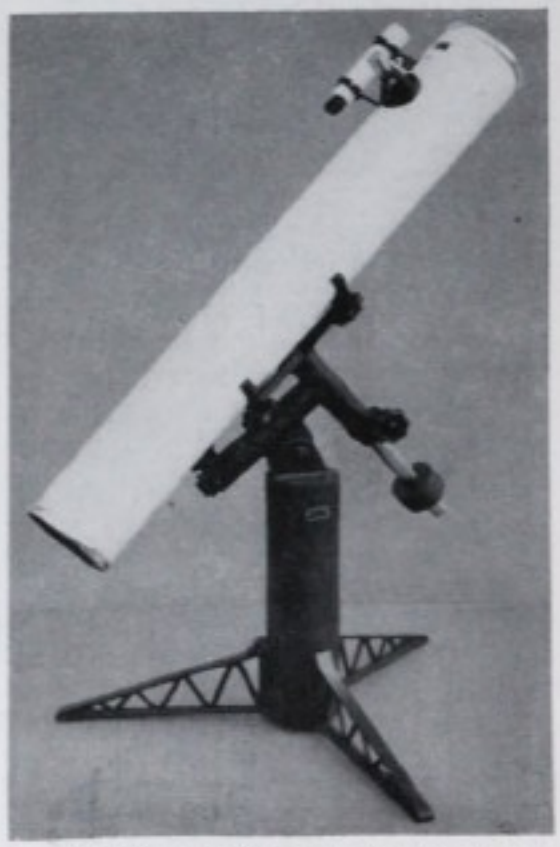

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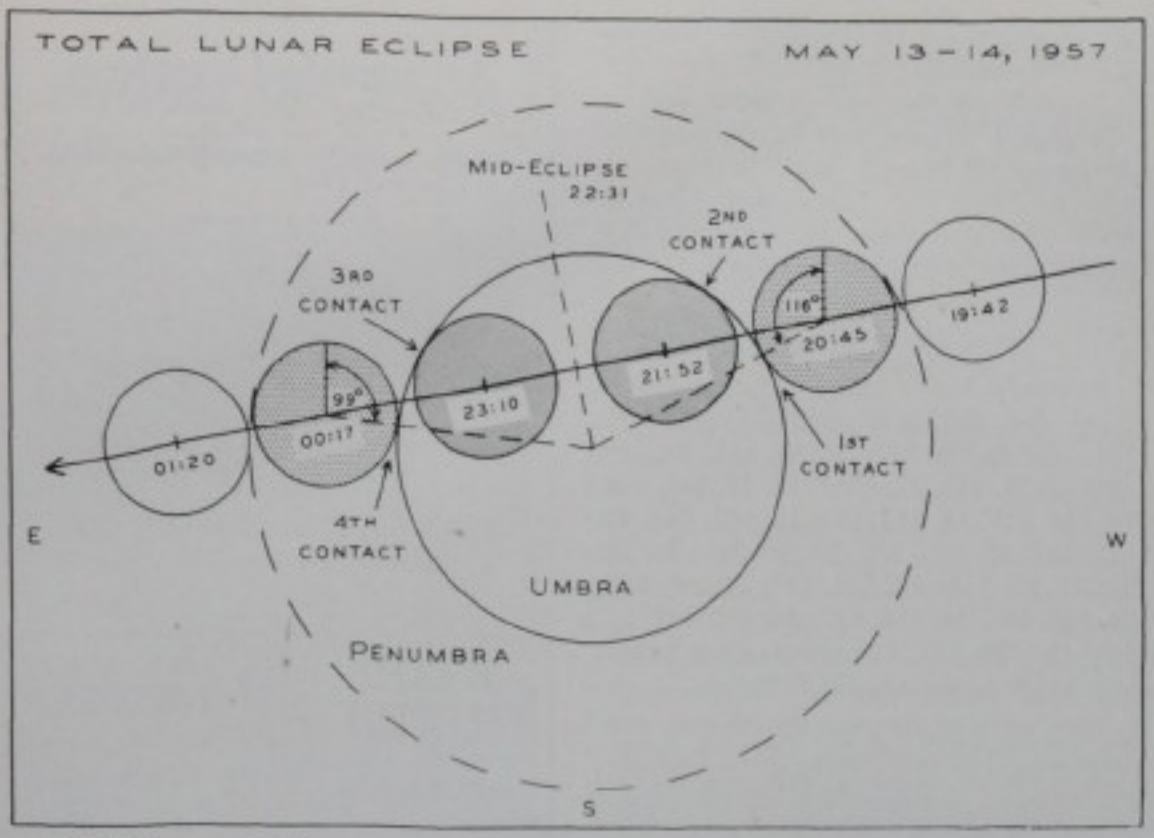


**This diagram of the passage of the moon through the umbra and penumbra of the earth's shadow is based on predictions in the "American Ephemeris and Nautical Almanac." The contacts are marked in Universal time.**

## The Eclipse of the Moon on May 13th

TWO TOTAL ECLIPSES of the moon will occur this year, the first on Monday, May 13th, the second on November 7th. Watchers in Europe and Africa will be able to observe the entire course of the May eclipse, but in the United States circumstances are unfavorable.

All along the eastern seaboard, from Maine to Florida, the full moon will rise that evening just as the sun sets, and it will have a peculiar appearance, for its upper limb will still be immersed in the umbral shadow of the earth. Emergence of the moon from the umbra is scheduled for 7:17 p.m. Eastern standard time (8:17 daylight time), while moonrise will occur at 6:57 in Miami, 7:09 at Charleston, 7:11 at Washington, D. C., 7:03 at New York City, and 6:55 at Boston.

It is evident that closing partial stages can be observed only with a clear eastern horizon, and that the sky will not become dark until the moon has passed nearly out of the penumbra. Observers not along the eastern seaboard will see little or nothing of this eclipse. But amateur astronomers in the central and western states will have compensation on November 7th, for that eclipse will be generally visible over the United States except its eastern part.

The times of the events of this month's eclipse are shown in the chart, but the first three contacts will occur while the moon is still below the horizon for every place on the North American mainland.


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## HIGH-SPEED STAR PHOTOGRAPHY

The advent of really high-speed plates and developers has made it possible to reduce exposures with fast lenses to a matter of seconds and still record fairly faint stars. This picture was made with an exposure of only six seconds, using a 70-mm. Ernostar lens at f/1.8 and an Ilford 6-by-9-cm. H.P.S. plate, contrast developed for 25 minutes at 20° C. in a fine-grain developer for high-speed film.

Similar results may probably be obtained with Kodak Tri-X film and Promicrol developer, provided a lens of similar or larger aperture and speed is employed. Experiment should determine the best exposure and processing times.

This technique makes it possible to reach stars as faint as magnitude 9.5 with a fixed camera; the exposures are so short that guiding is unnecessary. The method recommends itself for watching variables or detecting novae.

**Stars of the 8th magnitude are recorded in this six-second photograph of Orion, by Aage Nielsen. Betelgeuse is in the upper left.**


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**The Whirlpool nebula in Canes Venatici, as photographed on May 10, 1899, with the 36-inch Crossley reflector at Lick Observatory.**

### DEEP-SKY WONDERS

BELOW the handle of the Big Dipper lies a relatively barren region of Canes Venatici or, as some old French maps called it, the River Jordan. But this area contains a swarm of galaxies, including three Messier objects, M51, M63, and M94, the first located near the end of the Dipper handle, the last not far from Cor Caroli.

Rightly the most famous of these galaxies is M51, the Whirlpool nebula, which is at $13^h\ 27^m.8$, $+47°\ 27'$ (epoch 1950). It is of apparent magnitude 9, and the Shapley-Ames catalogue gives its dimensions as 12 by 6 minutes of arc. The main body of this galaxy is catalogued as NGC 5194, with its appendage, NGC 5195, connected to it by luminous material which may be seen with a telescope eight inches in aperture or larger.

M51 seems to be the first object in which the spiral-arm structure was detected. The discovery was made visually in 1845 with Lord Rosse's great 72-inch reflector at Birr Castle, Ireland. (A drawing by him and a two-page photograph taken with the 200-inch telescope of this magnificent object are available in the December, 1954, issue of *Sky and Telescope.)*

The Rosse instrument had a focal ratio of f/9, like many modern amateur reflectors, but it was the great aperture that turned the trick. The 36-inch reflector of Steward Observatory, Tucson, Arizona, enables a visual observer to see the arms with ease.

In Kansas, with my 10-inch f/8.2 reflector, I have noted the greater brightness of the two nuclei and the almost even luminosity of the other parts of the nebulous disks. Some foreground stars shine intermittently against the glow, but in moments of really excellent seeing the uniform glow vanishes and big swollen spiral arms appear for a tantalizing moment or two. Averted vision and exceptional sky conditions are essential for an adequate view.

On the same evening, my 6-inch f/4 telescope gave no trace of structure—only two glowing balls with small bright nuclei.

WALTER SCOTT HOUSTON
Rte. 3, Manhattan, Kans.

### THE APRIL 28TH OCCULTATION OF A STAR BY SATURN

The planet Saturn is scheduled to pass in front of the 8th-magnitude star BD $-20°$ 4568 during the morning hours of April 28th. On page 302 of the April issue, predicted times were quoted from the BAA *Handbook.*

Recent calculations at Harvard Observatory, by Dr. A. F. Cook and Fred A. Franklin, indicate that the phenomenon should begin about 11 minutes later than predicted for Lick Observatory, with immersion of the star behind the outer ring at 0:18 a.m. Pacific standard time on April 28th. Emersion from the outer ring is scheduled for 3:26 a.m., instead of 3:44 a.m., at Lick Observatory. These new times apply to within about 10 minutes over the United States. They are all uncertain by about half an hour.

Several observatories have scheduled studies of this phenomenon. The Harvard astronomers ask that amateur observers with large telescopes time the immersion and emersion of the star at the edge of the outer ring as accurately as possible. Full details of any observations of visibility of the star through the rings are important.


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## VARIABLE STAR MAXIMA

May 4, R Caeli, 043738, 8.0; 22, R Phoenicis, 235150, 7.8; 24, S Carinae, 100661, 5.7; 31, T Centauri, 133633, 6.1. June 7, W Lyrae, 181136, 8.0.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

## OCCULTATION PREDICTIONS

May 10-11 **Psi Virginis** 4.9, 12:52.1 −9-18.3, 11. Im: **H** 5:28.9 −3.2 +1.4 64.

May 18-19 **Beta Capricorni** 3.2, 20:18.6 −14-55.1, 20. Im: **F** 10:55.9 −1.8 +2.1 35.

May 19-20 **Nu Aquarii** 4.5, 21:07.3 −11-32.8, 20. Im: **H** 11:12.5 ..... 3. Em: **H** 11:52.5 ..... 310.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**LO** − **LoS**), and multiply **b** by the difference in latitude (**L** − **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

| | | | | | |
|---|---|---|---|---|---|
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| **B** | +71°.6, | +45°.5 | **F** | +98°.0, | +31°.0 |
| **C** | +77°.1, | +38°.9 | **G** | Discontinued | |
| **D** | +79°.4, | +43°.7 | **H** | +120°.0, | +36°.0 |
| | **I** | +123°.1, | +49°.5 | | |

## MOON PHASES AND DISTANCE

| | | |
|---|---|---|
| First quarter | May 7, | 2:29 |
| Full moon | May 13, | 22:34 |
| Last quarter | May 21, | 17:03 |
| New moon | May 29, | 11:39 |
| First quarter | June 5, | 7:10 |

| | May | Distance | Diameter |
|---|---|---|---|
| Perigee | 9, 3h | 229,200 mi. | 32′ 24″ |
| Apogee | 21, 16h | 251,100 mi. | 29′ 33″ |
| | **June** | | |
| Perigee | 3, 4h | 229,100 mi. | 32′ 25″ |

## MINIMA OF ALGOL

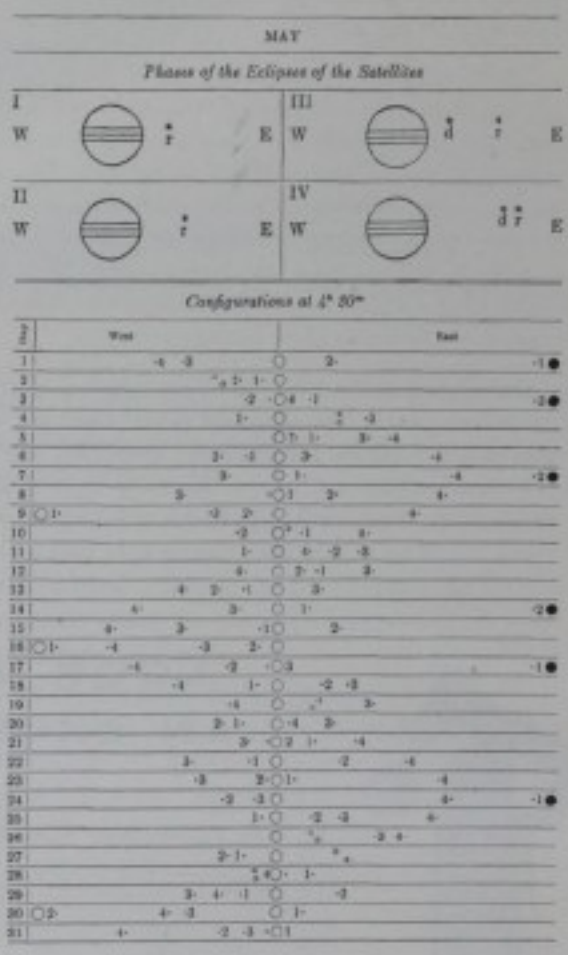
May 2, 22:08; 5, 18:57; 8, 15:46; 11, 12:35; 14, 9:24; 17, 6:13; 20, 3:02; 22, 23:51; 25, 20:40; 28, 17:29; 31, 14:18. June 3, 11:07; 6, 7:55.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

## JUPITER'S SATELLITES

The configurations of Jupiter's four bright moons are shown below, as seen in an astronomical or inverting telescope, with north at the bottom and east at the right. In the upper part, *d* is the point of disappearance of the satellite in Jupiter's shadow; *r* is the point of reappearance.

In the lower section, the moons have the positions shown for the Universal time given. The motion of each satellite is from the dot toward the number designating it. Transits over Jupiter's disk are shown by open circles at the left, eclipses and occultations by black disks at the right. The chart is from the *American Ephemeris and Nautical Almanac*.

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Some readers want microfilms of earlier volumes, as these are mostly out of print. University Microfilms will furnish a one-reel complete set of Vols. I through VIII (1941-1949), the reel to sell as a unit. If the company receives orders for five reels, the cost will be $17.50 per reel, but orders totaling 10 reels would reduce this to $15.00. As the final price will depend on the number of orders, all persons interested should communicate directly with University Microfilms not later than June 1, 1957, without obligation.


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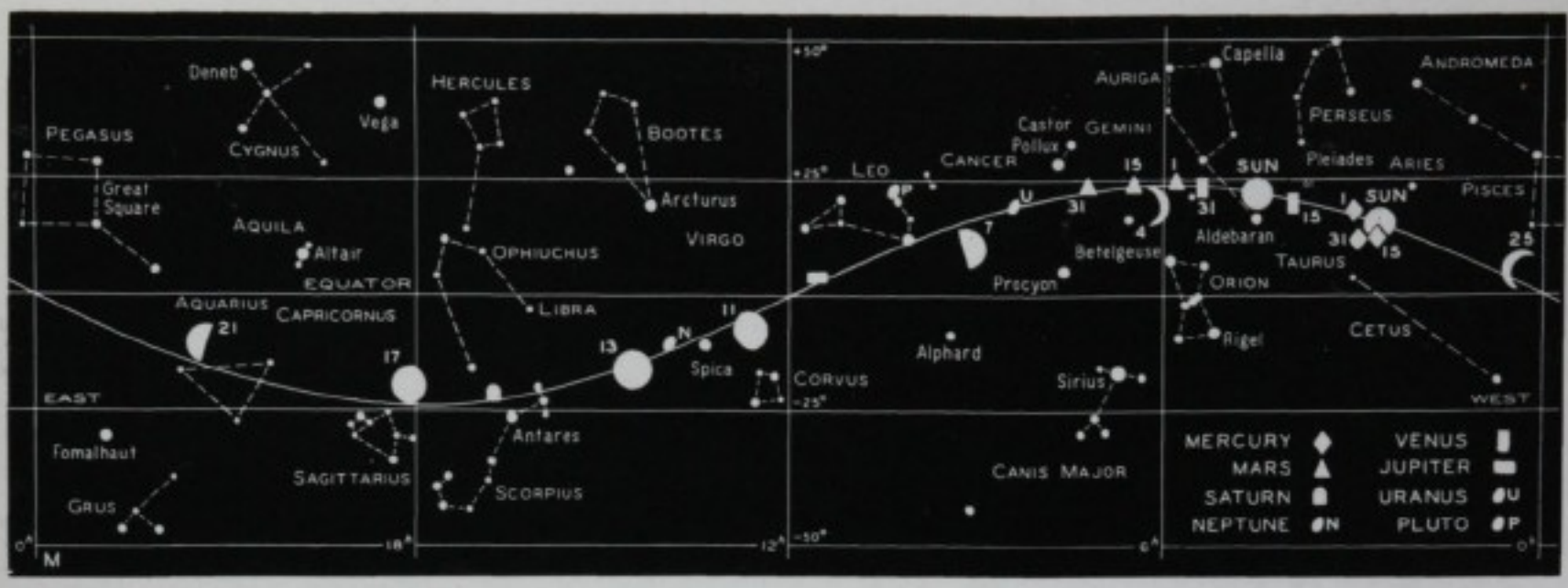


## THE SUN, MOON, AND PLANETS THIS MONTH

**The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month or for other dates shown. All positions are for 0h Universal time on the respective dates.**

**Mercury** passes inferior conjunction on May 6th, at which time the planet will pass in front of the disk of the sun. This event will be observable from most of the United States and Canada during the late afternoon of Sunday, May 5th, as described in detail on page 280 of the April issue. Although the transit is nearly a grazing one, it will last about 3½ hours. The next transit of Mercury is scheduled for November, 1960.

By the end of May, Mercury will be seen rising in the morning sky barely an hour before the sun, and it will be of the 1st magnitude. This is not a very favorable elongation for observers in mid-northern latitudes.

**Venus** will become visible low in the western sky just after sundown late in May, shining at magnitude −3.4. By the end of the month it will set just an hour after the sun.

**The moon** will be totally eclipsed on May 13-14, but the event will not be observable in the United States except for its closing stages along the Atlantic Coast. Details are given on page 350 of this issue.

**Mars** is moving rapidly eastward in Gemini, appearing as a reddish 2nd-magnitude object setting about three hours after the sun. On the 19th Mars passes less than a degree south of the star Epsilon Geminorum.

**Jupiter** dominates the evening sky, as it is near the meridian at sunset. The planet, on the boundary of Leo and Virgo, is shining at magnitude −1.8. Retrograde motion ends on May 19th, when Jupiter's equatorial diameter will be 39".7. The chart (opposite) of Jupiter satellite configurations shows that on May 1st, at 11:30 p.m. Eastern standard time (4:30 UT on the 2nd), all four of the bright moons will be to the west of the planet itself. At 11:30 p.m. EST on May 4th and 25th, they will all be on the east side.

**Saturn,** rising in the southeastern sky shortly after sunset, is of magnitude +0.3 in the middle of May. The planet is now moving westward in Ophiuchus and is at opposition to the sun on June 1st. There will be a close conjunction of Saturn and the moon on May 15th at 9:20 UT, with the planet only 10' south as seen from the center of the earth. An occultation of Saturn will be visible from parts of the Pacific Ocean. On the same date Saturn's ring system will be inclined 26°.0 to our view, with the northern face visible.

**Uranus** is moving eastward in Cancer, about 3½° west of the Beehive cluster (Praesepe). The planet is of the 6th magnitude.

**Neptune** may be viewed throughout the night in small telescopes. This 8th-magnitude planet is in slow retrograde motion 3½° west of Kappa Virginis. E. O.

### UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

### MAY METEORS

During the first 10 days of May, meteors of the Eta Aquarid shower may be seen in the morning hours. This stream, associated with Halley's comet, will reach maximum activity before dawn on the morning of May 5th, when up to 12 meteors per hour may be counted under good sky conditions. Moonlight will not interfere at that time. On the date of maximum, the radiant is at 22h 24m right ascension, 0° declination; it shifts northeastward by one degree per day. E. O.

### PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

**Iris,** 7, 9.4. May 2, 16:38.8 −24-41; 12, 16:30.7 −24-15; 22, 16:20.9 −23-41. June 1, 16:10.6 −23-00; 11, 16:00.7 −22-16; 21, 15:52.2 −21-34.

**Unitas,** 306, 9.8. June 1, 18:20.8 −11-52; 11, 18:14.2 −11-53; 21, 18:05.3 −12-12. July 1, 17:55.9 −12-47; 11, 17:47.5 −13-35; 21, 17:41.3 −14-33.

**Amphitrite,** 29, 9.3. June 21, 19:45.5 −30-25. July 1, 19:36.6 −30-52; 11, 19:26.2 −31-10; 21, 19:15.6 −31-17; 31, 19:06.0 −31-11. August 10, 18:58.4 −30-54.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.


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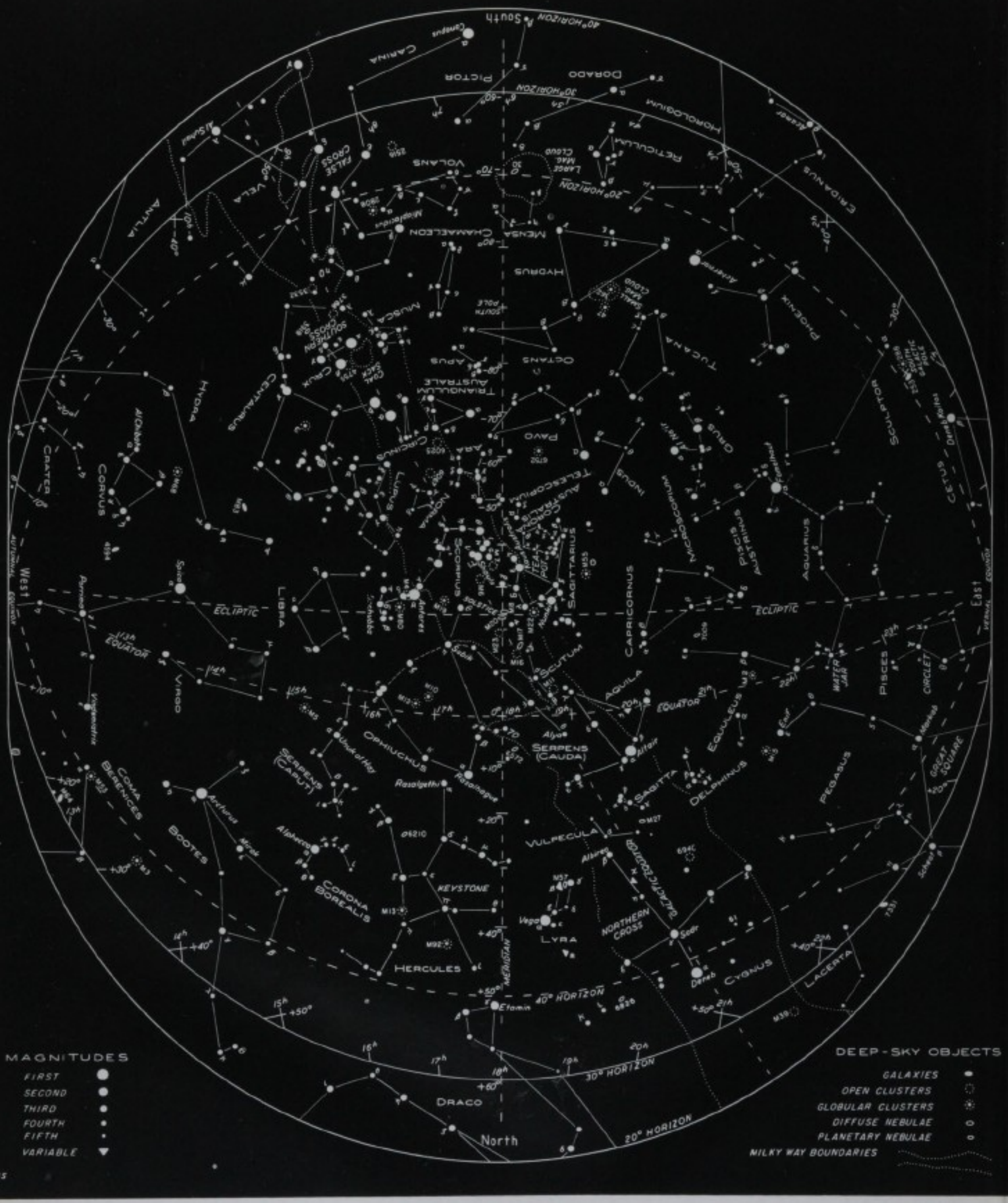
South
40° HORIZON
30° HORIZON
20° HORIZON
MERIDIAN
ECLIPTIC
EQUATOR
West
East
North
MAGNITUDES
FIRST
SECOND
THIRD
FOURTH
FIFTH
VARIABLE
DEEP-SKY OBJECTS
GALAXIES
OPEN CLUSTERS
GLOBULAR CLUSTERS
DIFFUSE NEBULAE
PLANETARY NEBULAE
MILKY WAY BOUNDARIES
CARINA
PICTOR
DORADO
RETICULUM
HOROLOGIUM
ERIDANUS
VOLANS
VELA
ANTLIA
MENSA
CHAMAELEON
HYDRUS
PHOENIX
TUCANA
OCTANS
APUS
TRIANGULUM AUSTRALE
PAVO
GRUS
INDUS
SCULPTOR
CETUS
CENTAURUS
HYDRA
CRATER
CORVUS
CRUX
ARA
TELESCOPIUM
MICROSCOPIUM
PISCIS AUSTRINUS
AQUARIUS
LUPUS
NORMA
SCORPIUS
SAGITTARIUS
CAPRICORNUS
LIBRA
VIRGO
OPHIUCHUS
SERPENS (CAUDA)
SERPENS (CAPUT)
AQUILA
EQUULEUS
DELPHINUS
SAGITTA
PEGASUS
GREAT SQUARE
PISCES
CIRCLET
WATER JAR
CORONA BOREALIS
BOOTES
HERCULES
KEYSTONE
VULPECULA
LYRA
NORTHERN CROSS
CYGNUS
LACERTA
DRACO
CORONA BERENICES
GALACTIC EQUATOR
Canopus
Achernar
Miaplacidus
Alphard
Alphecca
Arcturus
Spica
Antares
Rasalgethi
Rasalhague
Vega
Deneb
Altair
Fomalhaut
Markab
Scheat
Enif
Alpheratz
Etamin
Kochab
Mirfak
Unuk al Hai
Zubenelgenubi
Zubeneschamali
Dschubba
Nunki
Ascella
Kaus Australis
Kaus Media
Kaus Borealis
Sabik
Shaula
Lesath
Girtab
Yed Prior
Yed Posterior
Graffias
Dubhe
Merak
Phecda
Megrez
Alioth
Mizar
Alkaid
Polaris
Algol
Almach
Hamal
Sheratan
Mesarthim
Alpheratz
Ankaa
Diphda
Menkar
Acamar
Achernar
Rigel
Aldebaran
Capella
Bellatrix
Elnath
Betelgeux
Alnilam
Alnitak
Saiph
Mintaka
Procyon
Sirius
Adhara
Wezen
Aludra
Castor
Pollux
Alhena
Regulus
Denebola
Algieba
Zosma
Chort
Alphard
Kochab
Pherkad
Polaris
Alpha Centauri
Rigil Kentaurus
Hadar
Agena
Toliman
Alpha Crucis
Mimosa
Gacrux
Acrux
Becrux
Imai
Intrometida
Muhlifain
Gienah
Algorab
Kraz
Minkar
Alkes
Theemin
Nashira
Deneb Algedi
Dabih
Albireo
Sadalsuud
Sadalmelik
Skat
Fomalhaut
Matar
Homam
Biham
Sadachbia
Hydor
Sadalbari
Ancha
Baten Kaitos
Menkar
Diphda
Deneb Kaitos
Mira
Tau Ceti
Achernar
Acamar
Zaurak
Cursa
Nihal
Wezen
Adhara
Sirius
Mirzam
Furud
Naos
Suhail
Avior
Miaplacidus
Canopus
Rigel
Bellatrix
Mintaka
Alnilam
Alnitak
Saiph
Betelgeux
Aldebaran
Capella
Elnath
Menkalinan
Alhena
Wasat
Mebsuta
Tejat
Propus
Alzirr
Castor
Pollux
Procyon
Gomeisa
Regulus
Algieba
Adhafera
Rasalas
Denebola
Zosma
Chort
Coma
Vindemiatrix
Spica
Alkaid
Mizar
Alioth
Megrez
Phecda
Merak
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Cebalrai
Sabik
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Yed Posterior
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Dschubba
Acrab
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Deneb
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Markab
Algenib
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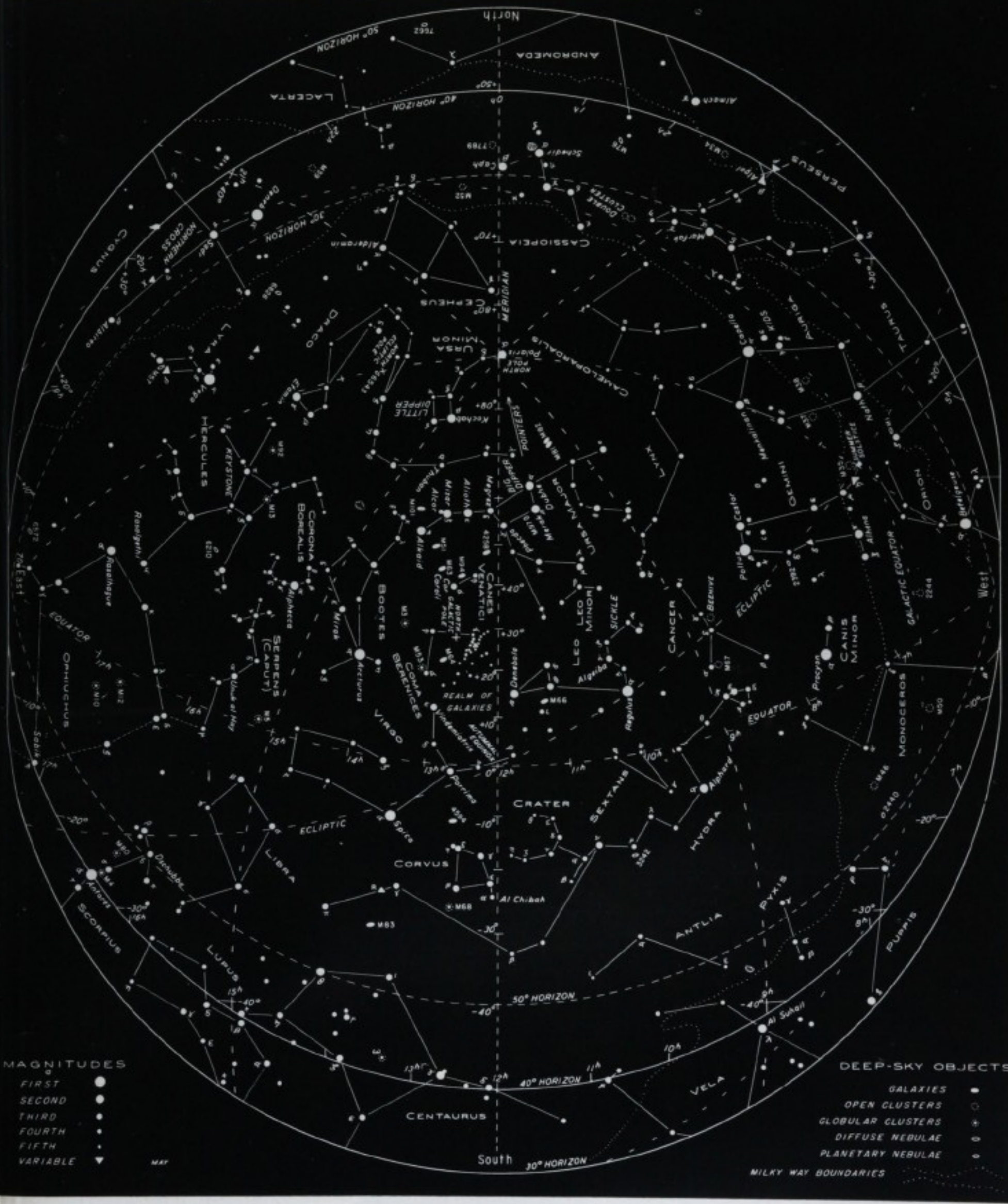
Caph
Schedar
Navi
Ruchbah
Segin




## STARS FOR MAY

The sky as seen from latitudes 30° to 50° north, at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of May, respectively. For other dates, add or subtract ½ hour per week.

At chart time Corvus the Crow and Crater the Cup are near the meridian in the southern sky. Look for Hydra the Water Monster winding beneath these two, and reaching up into the southwestern sky. Low in the southeast the Scorpion is just making its appearance, a harbinger of summertime.

# HITCH YOUR WAGON TO A STAR

Once more our mother earth in her sweep around the sun has brought us to the seasons that are fairest. These are the months for holiday excursions and adventure under new skies in distant places.

If you own a Questar, you will plan to take it with you, as a matter of course, in setting forth upon such pleasant journeys. This time, to the delight of your companions, you will have the telescope along, and no one will object to the modest half-cubic foot of space this little passenger requires.

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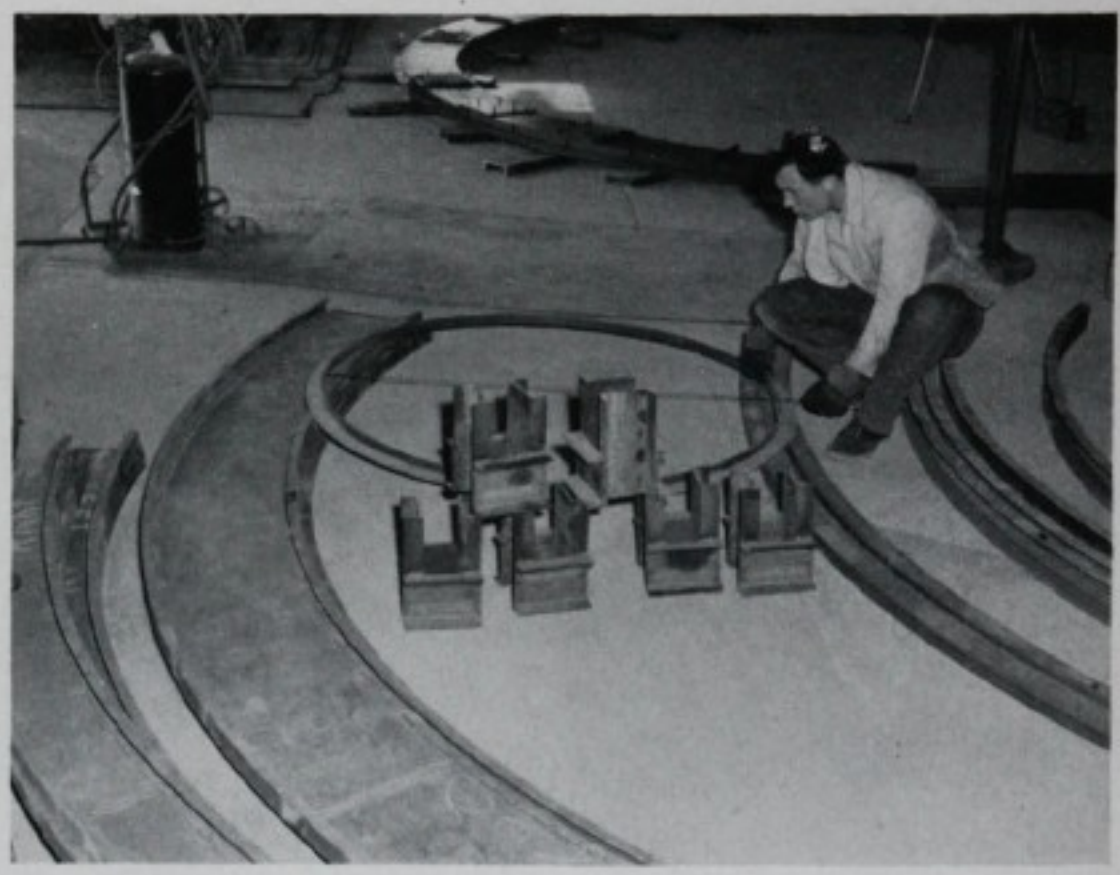
This experience with steel makes certain that an Astro-Dome will fit your most critical needs. During this year Astro-Domes are being designed and erected in many leading astronomical centers. We would be pleased to assist in your observatory plans as well.



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# When UNITRON invokes the Muse . . . watch out for the fuse

***Truly a talented trio!***

THE esoteric deliberations of contest judges seldom find their way into print. Those who adjudicate are generally uncommunicative; their reticence is doubtless born of a fear of bodily harm. Consequently, we consider it somewhat of a tour de force—and another UNITRON "first"—to be able to present an extract from the discussions leading to the choice of winners in UNITRON's Limerick Contest. You will recall (although you may wish to forget) that the contest, as announced in our February SKY AND TELESCOPE advertisement, was designed to dramatize the new UNITRON Easy Payment Plan, which makes it possible to own a UNITRON for only 10% down.

The symposium to follow was transcribed on March 16th by means of a tape recorder, borrowed from a MOONWATCH crew. The proceedings were furtively observed by a member of the UNITRON staff—chosen from among those whose ancestors had fought in the war (the Trojan War, that is)—who was concealed for the occasion inside the tube of a UNITRON 6" Photo-Equatorial Refractor (the forthcoming model, that is). It might be noted at this point that our tubes and mountings are extremely sturdy. The UNITRON had been planted in the conference room under the pretext of providing the judges with an inspiring and dignified atmosphere in which to ponder.

The judges were: Dr. Giama Whizz (qualified by virtue of his technical noknowhow), inventor of UNITRON's forthcoming new eyepiece, the "jocular ocular"; Naels Van Hardflint (formerly an actor's agent and hence an authority on 10%), presently in charge of UNITRON's Easy Payment Plan; and Apollo (noted consultant on artistic matters), leader of the Muses. Truly a talented trio!

* * *

APOLLO: τινα γνωμην εχετε

VAN HARDFLINT: Speak English, Apollo! We're taking enough of a linguistic licking from the language in these limericks without listening to your learned lingo.

DR. WHIZZ *(with irritation)*: I second the motion. Were it not for your supercritical judgment, we could have chosen the winners long ago and I could return to my laboratory and resume work on my new UNITRON invention: a clock drive with built-in music box offering a choice between "Twinkle, Twinkle, Little Star" and "Stars Fell on Alabama." I don't want to hurt your feelings Apollo but, frankly, how in the name of 10% *you* ever got to be a judge in this contest is completely beyond me. After all, the limerick seems to be historically associated with Ireland, not Greece. It would have seemed more logical if . . .

VAN HARDFLINT *(breaking in)*: I can answer that. Originally, they tried to get Dáibhidh Ó Bruadair, but he was too busy getting ready for the St. Patrick's Day parade and didn't have time.

APOLLO: Stop picking on me, you barbarians. Don't forget that because I am leader of the Muses, Urania (muse of astronomy) comes under my direct supervision. While I am naturally too much of a gentleman to throw my weight around, you are doubtless aware that a word from me would be sufficient to displace you from your soft jobs at UNITRON. I refuse to budge one iota in my insistence that the winning verses really be *limericks* as required by the contest rules. Just look at this collection of entries! Besides limericks, we have single lines, couplets, triplets, quatrains, sestets and "etcetlets"; sonnets, slogans, roundelays, madrigals, elegies, ballads, macaronics, plus an epic in the style of Beowulf; meter in iambus, dactyl, spondee, trochee, Alexandrine and one Volta; verse inscribed on paper, parchment, papyrus, cardboard, clay tablets, birch bark, copper plate, as well as one on a paper napkin; written with pencil, pen, crayon, typewriter, brush, lipstick . . . . Whew, I'm out of breath!

DR. WHIZZ *(glancing at a piece of paper which he has been using as a fan)*: This one must be in blank verse—there's no writing on it. Say, maybe it's written in lemon juice and will become visible when we heat it! I'll just focus the sun's rays with this UNITRON achromatic objective and . . .

VAN HARDFLINT *(raps Dr. Whizz sharply across the knuckles with a UNITRON 4" Sunscreen rod)*: Cut that out! With all this paper piled around, we could have another Chicago fire! By the way, Apollo, just how many entries did we get?

APOLLO: Laid end to end, they would stretch for many a parasang. *(peruses a scroll withdrawn from the folds of his robe)* Let me see: 514 people, and two occupants of outer space who belong to an undetermined phylum, submitted a total of 1,279 entries. Incidentally, we also got a letter suggesting a name for UNITRON's Rotary Eyepiece Selector—someone is evidently using an old Julian Day calendar and isn't aware that the contest to name UNIHEX ended long ago.

VAN HARDFLINT: All in all, that amounts to a prolific pile of poetry. *(mumbles to himself as he jots some figures on the margin of a UNITRON catalog sheet)* Four eights are thirty two . . . carry the three . . . Yes, that figures. The total number of man hours devoted to concocting limericks for this contest would have been sufficient to give two coats of plaid paint to the Great Wall of China.

APOLLO: The most unfortunate part of this UNITRON Contest was that so many astronomers shamefully neglected their observing these past few months. The Mercury Messenger Service has just delivered a letter from Dr. Llayam of the Anglican Association of Admirers of Alternating Asters which mentions that even some of their most stalwart stargazers forsook Mira for the Muse. In fact, one confused chap even sent in his observations to the A.A. of A. of A.A. in the form of a limerick.

DR. WHIZZ *(impatiently)*: All this tongue-flapping may stir up a breeze, but it isn't giving us the winners. *(leaps to his feet and gesticulates in the manner of Frankenstein conceiving the idea to build his monster)* I have a terrific plan! Why don't we make paper airplanes out of all these entries, launch them in flight, and let the five that fly farthest be the winners? Then I can go back to my laboratory and work on my new black bulb which when turned on in the daytime will make things dark so that observers can . . .

APOLLO *(cutting him short)*: Nothing doing! If Rhadamanthus ever got wind of such aerodynamical shenanigans, he'd give me Hades.

* * *

At this point, the tape stopped dead in its tracks. Mention of the word Hades had so overloaded the recorder that it blew a fuse. And unfortunately our own observer, hidden inside the tube of the UNITRON 6", had simultaneously succumbed to lack of oxygen (refractors, unlike reflectors, tolerate no moving air currents) and malnutrition (from the weeks of starvation needed to reduce his diameter to tube size). As a consequence of this dual calamity, the world will never know exactly how the judges selected the final winners, although we may rest assured that they judged according to the best of their inabilities.

All attempts to complete the picture by interrogating Van Hardflint have been unsuccessful. His lips are sealed, or more accurately, mangled. Since his eye is also blackened, we strongly suspect that after the tape broke the session may have been a bit heated. Yet in all fairness, we must not draw inferences too hastily. After all, the labial lacerations may have been caused by a bubble-gum explosion and the darkened organ of vision may merely be a superficial deposit of lampblack acquired from viewing through Dr. Whizz's new "jocular ocular." In any event, we feel confident that the selection of the winners was not easy, since the judges instructed that an additional 10 prizes (UNITRON 23.5-mm. view finders) be awarded as honorable mentions.

Arrangements are being made to engrave the winning limericks and the names of their authors on the Blarney stone, in Gaelic. Those who would find it more convenient to read them in English should . . .

***see pages 346 and 347.***

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